I Goofed! Confessions of a Skyshooter

ASTRONOMY®

What Will Replace The Space Shuttle?

August 1995 U.S. $3.50
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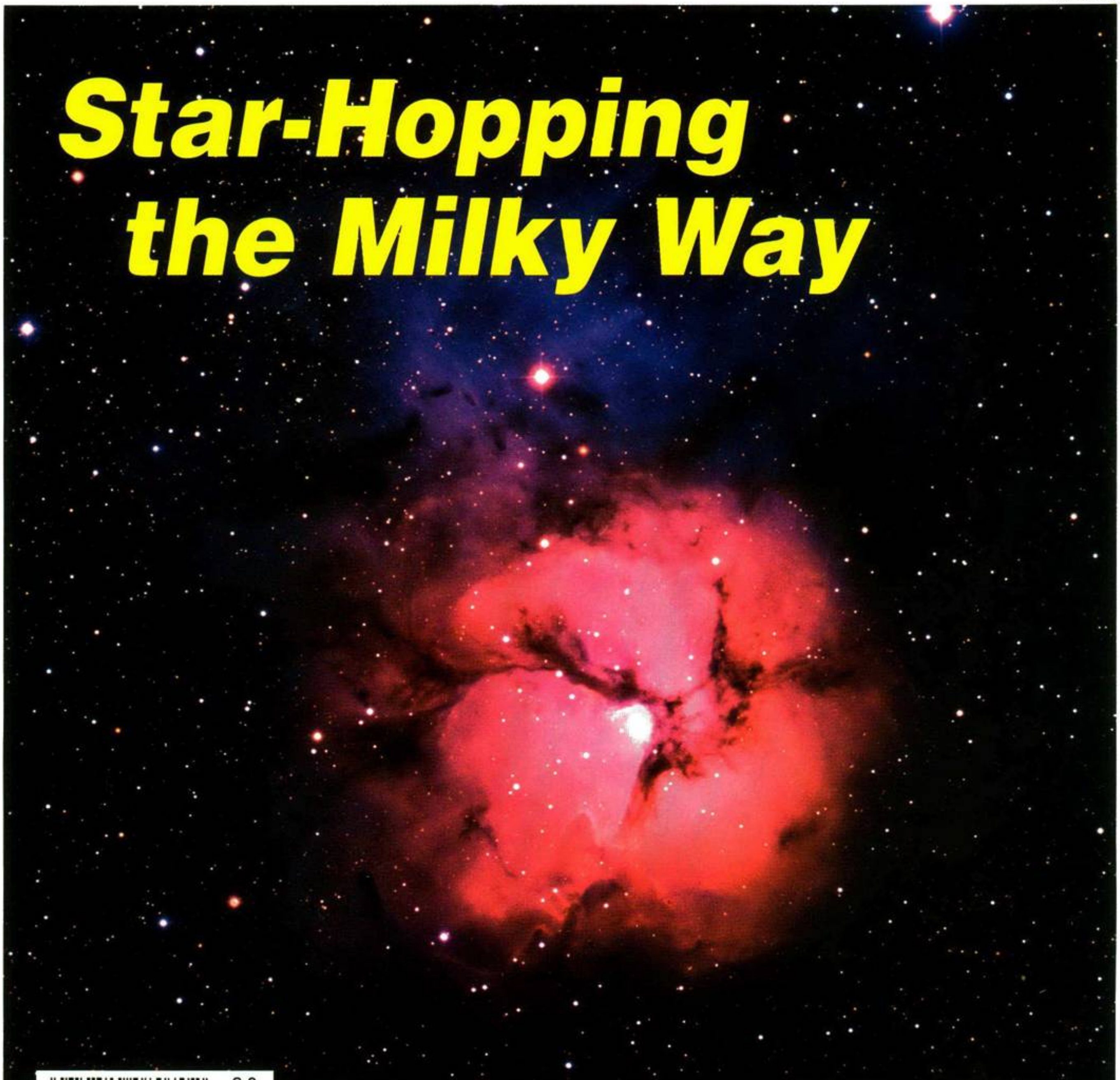
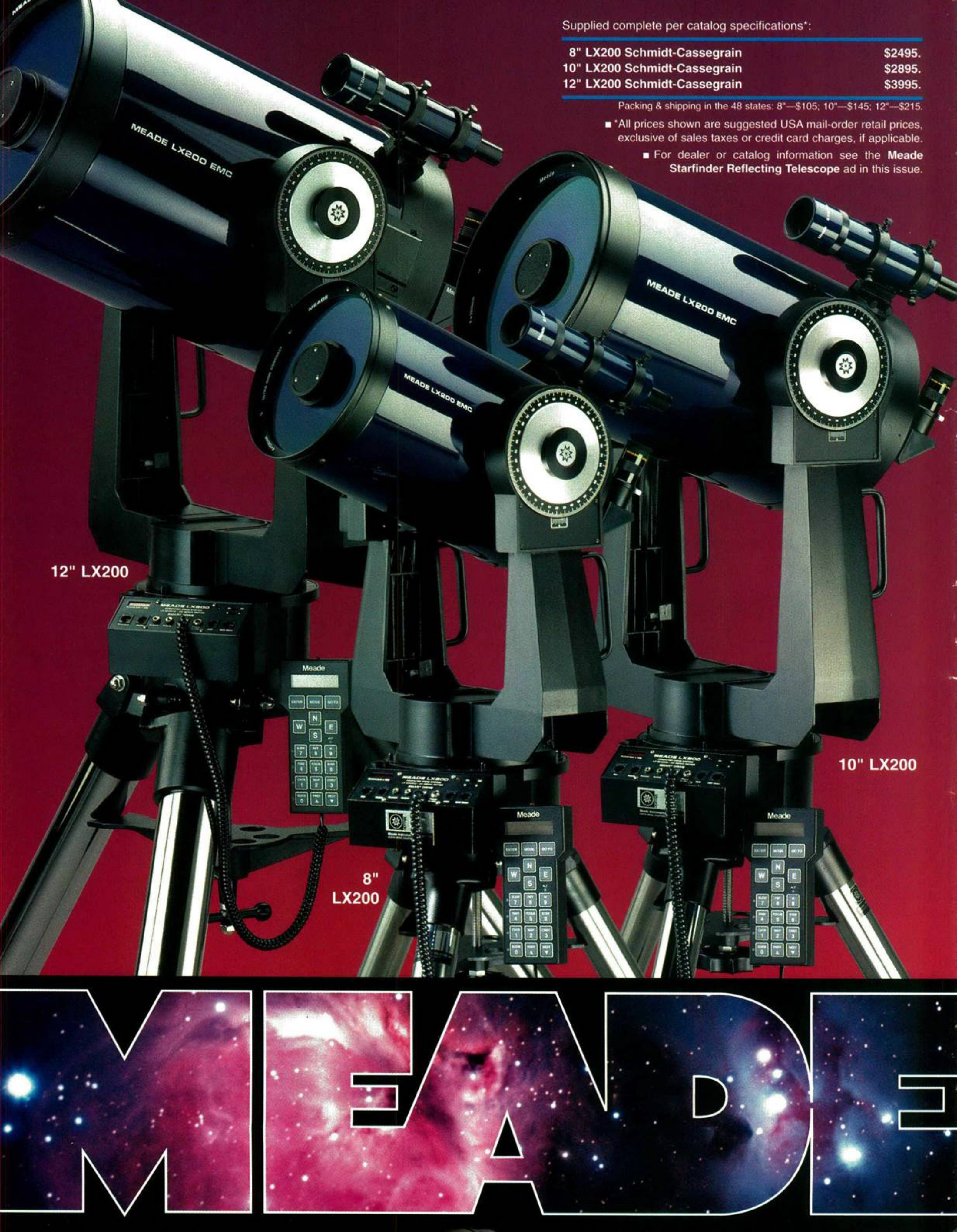


Star-Hopping the Milky Way

- Build a Handy Binocular Mounting
- Mars Rocks Found on Earth


12" LX200
8" LX200
10" LX200
MEADE LX200 EMC
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Supplied complete per catalog specifications*:

8" LX200 Schmidt-Cassegrain	$2495.
10" LX200 Schmidt-Cassegrain	$2895.
12" LX200 Schmidt-Cassegrain	$3995.

Packing & shipping in the 48 states: 8"—$105; 10"—$145; 12"—$215.

- *All prices shown are suggested USA mail-order retail prices, exclusive of sales taxes or credit card charges, if applicable.
- For dealer or catalog information see the **Meade Starfinder Reflecting Telescope** ad in this issue.

THE TELESCOPE STANDARD OF THE WORLD.

In virtually every country in the world where serious telescopes are sold, more Meade® LX200's are sold than all competing models combined.

In school, college, and university teaching programs, among visual observers, astrophotographers, CCD imaging specialists, and advanced amateurs worldwide, Meade LX200 Schmidt-Cassegrains are, far and away, the Number One choice. No other telescopes offer the LX200's combination of state-of-the-art, standard-equipment features:

■ **Superb Optics:** LX200 optical imaging capabilities are a legend in the industry; we regularly receive user reports to the effect that optical performance approaches that of a fine *ED* apochromatic lens.

■ **Tracking precision:** The LX200's permanently-programmable Smart Drive™ routinely achieves a tracking periodic error of 5 arc secs. or better, the standard for large observatory instruments.

■ **Automatic GO TO capability:** Meade LX200's are *the only commercial telescopes ever manufactured* that automatically GO TO any input R.A. and Dec. coordinates to a precision of *one arc-minute or better.*

■ **64,350-Object onboard database:** Imagine having 64,350 celestial objects at the tip of your finger: 64,350 objects—galaxies, nebulae, globular clusters, double stars, planets, objects of every description—*that you can center in the telescopic field just by entering and pressing GO TO on the hand controller.* The Meade 64,350-object library includes an incredible array of phenomena, virtually a lifetime of deep-space study, even for the advanced observer:

12,921	galaxies from the Uppsala General Catalog; the complete UGC catalog.
7,840	objects from the New General Catalog; the complete NGC catalog.
5,386	objects from the Index Catalog; the complete IC catalog.
21,815	variable stars; the complete listing from the General Catalog of Variable Stars.
15,928	stars from the Smithsonian Astrophysical Observatory (SAO) catalog of stars brighter than 7th magnitude.
351	alignment stars for the LX200 telescope.
110	Messier objects; the complete listing.
8	major planets from Mercury to Pluto.
64,359	objects, total

LX200

SCHMIDT-CASSEGRAINS

■ **Meade High-Precision Pointing™** is so precise that it permits the positioning of *every* selected object on *every* commercially-available CCD chip *every* time, automatically. Photographing or CCD imaging faint objects *at or past the visual observing limit (e.g.,* the planet Pluto or a supernova in an 18th-magnitude galaxy) is not only practical, but routine, because of the extreme precision with which the LX200 positions the object on to the CCD chip or in the telescopic field.

■ **9-Speed Dual-Axis Electronics:** Electronics that cover every possible contingency of telescope positioning—from 2x photo-guiding, to 32x image centering, to 8°/sec. slewing across the sky, as well as 6 other dual-axis drive speeds in between.

■ **Field Portability and Operation:** No other telescopes of such sizable apertures and incredible capabilities transport so readily for field operation. Field set-up requires only minutes, and the optional #1812 Electronic DC Adapter (a compact 4 oz. unit) allows for field powering of the telescope directly from a 12-volt auto cigarette lighter plug.

SPECIFICATIONS: 8", 10", and 12" LX200's—Each complete telescope includes 8" or 10" (f/6.3 or f/10) or 12" f/10 Schmidt-Cassegrain optical tube assembly with EMC super multi-coatings; heavy-duty fork mount with 4" polar ball bearing, dual-axis 5.75" worm gears, and multi-function control panel display on the drive base; manual and electric slow-motion controls on both axes; keypad handheld controller with digital readout display, permanently programmable Smart Drive™, 9-speed drive controls on both axes (7-speed on 12"), High-Precision Pointing, and GO TO controller; 64,350-object onboard celestial software library; 25 ft. power cord and adapter for telescope operation from 115v.AC (for field operation from any 12v. auto cigarette lighter plug, use the Meade #1812 Electronic DC Adapter, a 4-oz. unit available optionally); 8 x 50mm viewfinder with crosshairs; 1.25" diagonal prism (8", 10") or 2" diagonal mirror with 1.25" adapter (12"); Series 4000 Super Plössl 26mm eyepiece; standard field tripod (8", 10") or giant field tripod (12"); foam-fitted carrying case; complete operating instructions.

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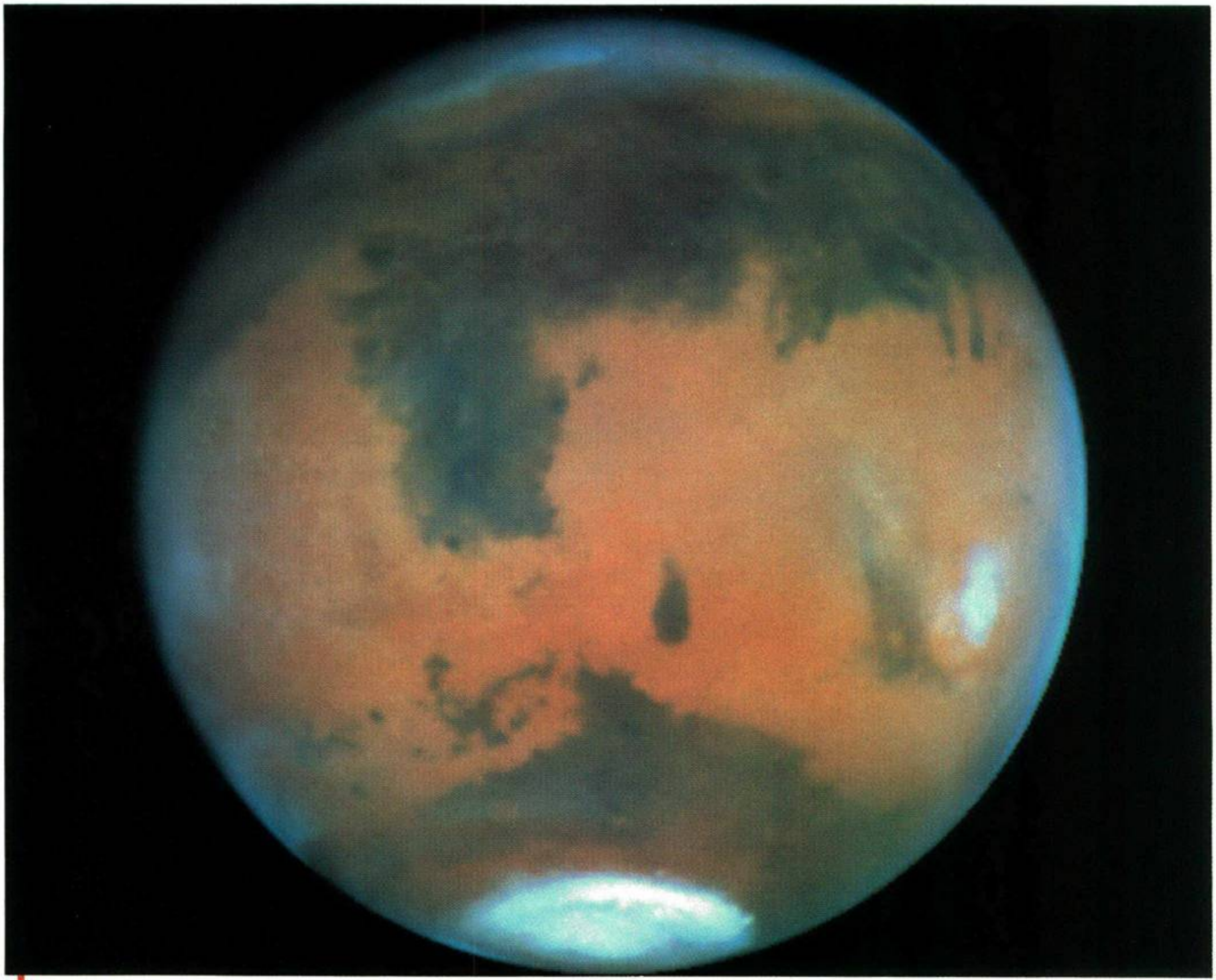

NASA/HST

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Those lazy, hazy days of summer can be an observer's best friend. By Jeff Kanipe.

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Enormous impacts blasted bits of the Red Planet all the way to Earth. What story do they tell of Mars' history and violent collisions between asteroids and planets in the early solar system? By Mark Robinson and Meenakshi Wadhwa.

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BRILLIANT REDS AND SUBTLE BLUES highlight the famed Trifid Nebula (M20) in Sagittarius. Learn how to find this and other deep-sky wonders easily by hopping from star to star (page 76). UK Schmidt/Royal Observatory, Edinburgh photo.

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Banish tired arms and shaky views with this sturdy, easy-to-build mount for your binoculars. By David Rogers.

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See You at the Hop

Most beginners wonder if they'll ever find the night's many deep-sky wonders. Relax: A simple technique called star-hopping will have you navigating the universe in no time. By Robert Garfinkle.

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BEHIND THE SCENES

Arrivals and Departures

ASTRONOMY's masthead this month (bottom of the page) has some new names on it. These reflect "people changes" as we welcome the arrival of two new staff members and salute the departure of another.

First, we say a fond good-bye to Rhoda Sherwood, who has been our managing editor since July 1990. During these five years, it has been Rhoda's job to keep ASTRONOMY (and its editors!) on schedule so that you receive the magazine on time each month. Blessed with a great sense of humor, she has done this difficult task with a wonderfully effective mixture of cajoling, hectoring, cheerful nagging, and flinty-eyed pressure. What's more, she's done all this while also being managing editor at *Earth*, ASTRO's sibling magazine. As she sets down her ASTRO responsibilities, Rhoda will continue with *Earth* and pick up new ones for two of Kalmbach's other magazines, *Classic Toy Trains* and *Collecting Toys*.

The Gang of Three: Bob Naeye, Jeff Kanipe, and Rhoda Sherwood.

Back at ASTRO, we welcome back Jeff Kanipe as our new managing editor. A former associate editor with ASTRONOMY, Jeff left us five years ago to take the helm of *StarDate*, the magazine associated with the NPR radio series produced by the McDonald Observatory. He's keenly interested in all facets of astronomy (especially cosmology), and you'll be seeing his byline on stories to come.

Joining Jeff — actually, he's been with us for a couple months now already — is Robert Naeye. Bob comes to us from *Discover* magazine, where he spent two and half years as a news-writer and researcher in the physical, geological, and biological sciences. His specialty was astronomy. You'll be seeing his byline in months to come, too.

Welcome aboard!

Sincerely,

Robert Burnham

Robert Burnham
Editor
rburnham@astronomy.com

(By the way, if you want to contact our Customer Service department electronically, the address is: customerservice@kalmbach.com. And if you want to write me or one of the other editors on-line, our addresses are constructed like mine [above]: first initial plus last name followed by @astronomy.com, all with no spaces.)

LETTERS

More Challenging Planetaries Out There

Planetary nebulae are among the most varied objects visible in backyard telescopes. But in his article, "Challenging Planetary Nebulae," (March 1995) John Franch left out two large, faint planetary nebulae that are among my favorites: The Medusa Nebula (PK 205 +14.1) and Jones 1 (PK 104-29.1). Both show subtle detail that make them well worth the effort.

The Medusa Nebula is visible in the late winter and early spring skies, 30' southeast of NGC 2395 in Gemini. With a visual magnitude of 10.3 and a diameter of 615", it's a challenge for any small scope with 12 to 14 inches of aperture.

Jones 1 appears 1 degree south-southeast of 72 Peg in the late summer and early fall skies. Its magnitude of 12.1 and 332"-diameter make it a slightly more difficult object to locate than the Medusa Nebula.

Using a nebula filter will help when it comes to observing both of these faint beauties. But under dark skies, I've had luck finding them at low power even without a filter. — *Miles Paul, Victoria, British Columbia, Canada*

Sagan's New Planet

Carl Sagan's story about Uranus strikes me as one of your magazine's very best articles. He combines both history and astronomy in an immensely readable way. I look forward to more contributions like this. — *Matthias Ellinger, Saarbrücken, Germany*

As Constant as the Northern Star

Has Robert Zimmerman not heard of precession ("Polaris: The Code Blue Star," March 1995)? Far from holding its "fortuitious position . . . since the beginnings of written history," Polaris has not even come closest to its position as

(continued on page 12)

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If you're ready to join the CCD revolution, send for a copy of the 76-page *Meade® 1995 General Catalog* ($3.00), which includes a substantive introduction to CCD astronomy, or contact your authorized Meade Advanced Products dealer. *Meade Pictor CCD imagers are available from $795.*

Upper left: **Meade Pictor 416 image by Steven Williams**—Alphonsus/Ptolemaeus region of the Moon. *Clockwise from upper right:* **Meade Pictor 1616 images by Jack Newton**—M101; NGC4565; M51.

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Now you can buy a Dobsonian telescope with quality Meade® optics and components—at a fraction of the price you'd expect to pay.

And receive a $125 Accessory Package for only $49.95!

10" f/4.5
$595.

12.5" f/4.8
$795.

8" f/6
$425.

Shown with optional #637 6 x 30mm or #545 8 x 50mm Viewfinders

6" f/8
$325.

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STARFINDER
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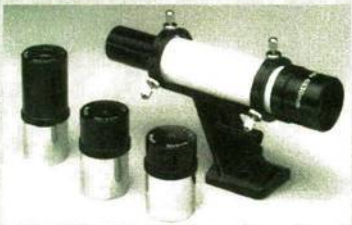
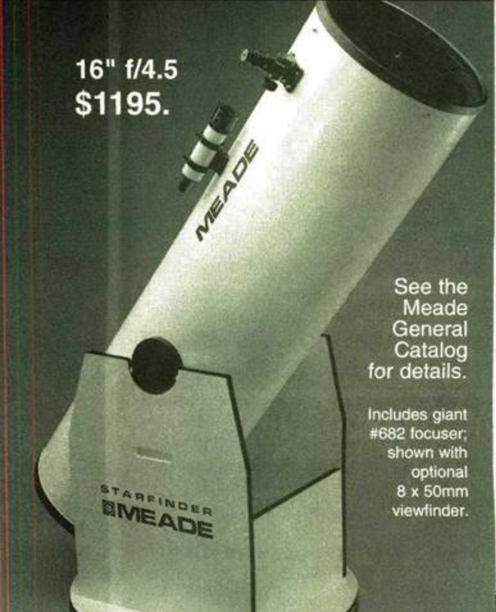
SPECIAL ACCESSORY OFFER!

At the time you order any Starfinder 6", 8", 10", 12.5", or 16" Dobsonian Telescope, you can buy **two additional Meade multi-coated Modified Achromatic MA9mm and 12mm eyepieces *and* the Meade #637 6 x 30mm coated achromatic viewfinder with metal bracket for a *total* of only $49.95! Purchased separately, the 2 additional eyepieces and viewfinder sell for $125.85!** *(Shown in photo: MA9mm, MA12mm, and standard-equipment MA25mm eyepieces, with #637 6 x 30mm viewfinder.)* Offer valid until further notice.



Starfinder Dobsonian 16



16" f/4.5
$1195.

See the Meade General Catalog for details.

Includes giant #682 focuser; shown with optional 8 x 50mm viewfinder.

Compare Meade Starfinders *feature-for-feature* with other similarly priced Dobsonians!

- **Primary and Secondary Mirrors of Low-Expansion Pyrex® glass!** Unlike the plate-glass optics of other Dobsonians that can become thermally unstable (especially in larger apertures), Meade Dobsonians include the *exact same* professional-quality Grade-A, fine-annealed Pyrex® optical systems used on Meade Starfinder Equatorial Reflectors. Optics that meet the theoretical limits of resolution for their apertures.
- **Precision Rack-and-Pinion Focuser!** An industry-standard full-size rack-and-pinion system with 2.6" of focus travel.
- **Fully-Adjustable 4-vane Secondary Mirror Systems!** *Rigid 4-vane systems* that permit precision alignment of the secondary mirror to the primary mirror.
- **Rigid, Durable, Beautiful Dobsonian Mountings!** Mountings that provide extremely smooth motions of the telescope in both altitude and azimuth. Both telescope axes ride on zero-backlash Teflon/Nylon bearings, facilitating the location and tracking of celestial objects anywhere in the sky. Each mount is manufactured of cabinet-quality materials and designed for a lifetime of use. Handles are provided for easy portability.
- **Optical Tubes:** Starfinder Dobsonians include the same strong, spiral-wound optical tubes used on Starfinder Equatorials *(facing page)*. All telescopes include a multi-coated MA25mm eyepiece as standard equipment. Each tube is factory pre-drilled for the optional 6 x 30mm or 8 x 50mm viewfinder.
- **Performance!** A Meade Starfinder Dobsonian or Equatorial Telescope opens up the skies to an extremely wide range of serious visual observing: all 110 Messier objects, thousands of NGC objects–nebulae, galaxies, star clusters, in all their variations of form, color, and extent, as well as the Moon and planets in stunning, high-resolution detail. Starfinder Dobsonians are telescopes for visual observing; motor-driven Starfinder Equatorials may be used, in addition, for lunar and planetary photography and even for limited deep-space astrophotography.
- **Packing and UPS Shipping Charges:** to any address in the 48 states: 6"–$39; 8"–$49; 10"–$69; 12.5"–$79. 16"–$45 packing, shipped truck freight collect.
- **To Order:** Contact one of the authorized mail-order dealers on the facing page.

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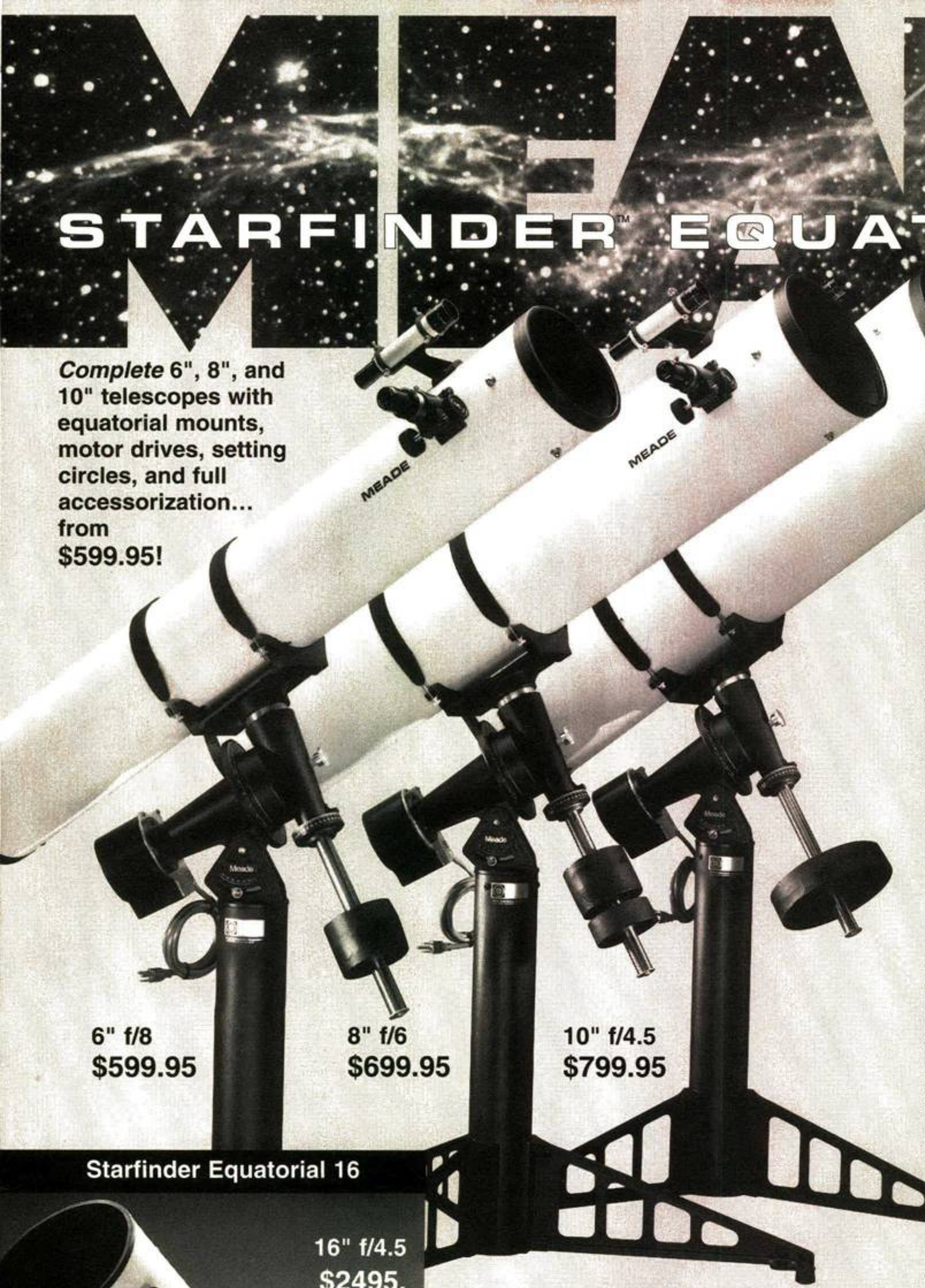
STARFINDER™ EQUATORIALS



Complete 6", 8", and 10" telescopes with equatorial mounts, motor drives, setting circles, and full accessorization... from $599.95!

6" f/8
$599.95

8" f/6
$699.95

10" f/4.5
$799.95

- **Electric Motor Drive** (115v/60Hz) with 6 ft power cord: permits **fully automatic** tracking of celestial objects; plugs into any standard outlet.
- **Standard Accessories and Components:** Precision Rack-and-Pinion Focuser (1.25") with full 2.6" travel; coated achromatic #637 6 x 30mm Viewfinder with crosshair eyepiece and 7° field; multi-coated MA25mm (1.25") eyepiece, threaded for filters; strong, durable, spiral-wound optical tube with attractive white finish.
- **Optional Accessories:** See the Meade accessories ad in this issue. Additional systems, including #55 Manual Declination Control, #43 Drive Corrector, and #47M Dual-Axis Drive Corrector, are described in the Meade General Catalog.

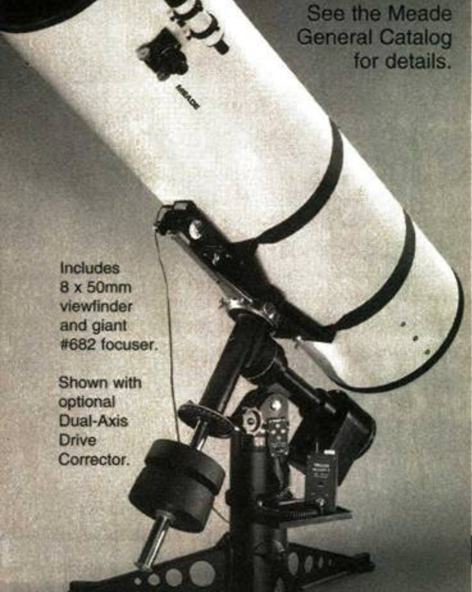
SPECIAL ACCESSORY OFFER! At the time you order any Starfinder 6", 8", 10", or 16" Equatorial Telescope, you can buy **two additional Meade multi-coated Modified Achromatic MA9mm and 12mm eyepieces for a *total* of $29.95! Purchased separately, the two additional eyepieces sell for $75.90.** *(Shown in photo: MA9mm, MA12mm, and standard-equipment MA25mm eyepieces.)* Offer valid until further notice.

- **Packing and UPS Shipping Charges:** to any address in the 48 states: 6"–$65; 8"–$75; 10"–$90. 16"–$55 packing, shipped truck freight collect.
- All prices shown are suggested USA mail-order retail prices, not including any applicable sales taxes.
- **Meade 1995 General Catalog** — $3.00 postpaid—is available from any authorized Meade dealer or directly from Meade Instruments.
- For further information call Meade Instruments at 714-756-2291 or contact one of these authorized mail-order dealers:

Starfinder Equatorial 16

16" f/4.5
$2495.

See the Meade General Catalog for details.



Includes 8 x 50mm viewfinder and giant #682 focuser.

Shown with optional Dual-Axis Drive Corrector.

Standard equipment on 6", 8", and 10" models includes:

- **Superb Optical System:** Includes hand-figured parabolic primary mirror that meets the theoretical limit of resolution for its aperture, with matching elliptical flat secondary mirror. Both mirrors multi-coated and made of low-expansion, Grade A, fine-annealed Pyrex® glass.
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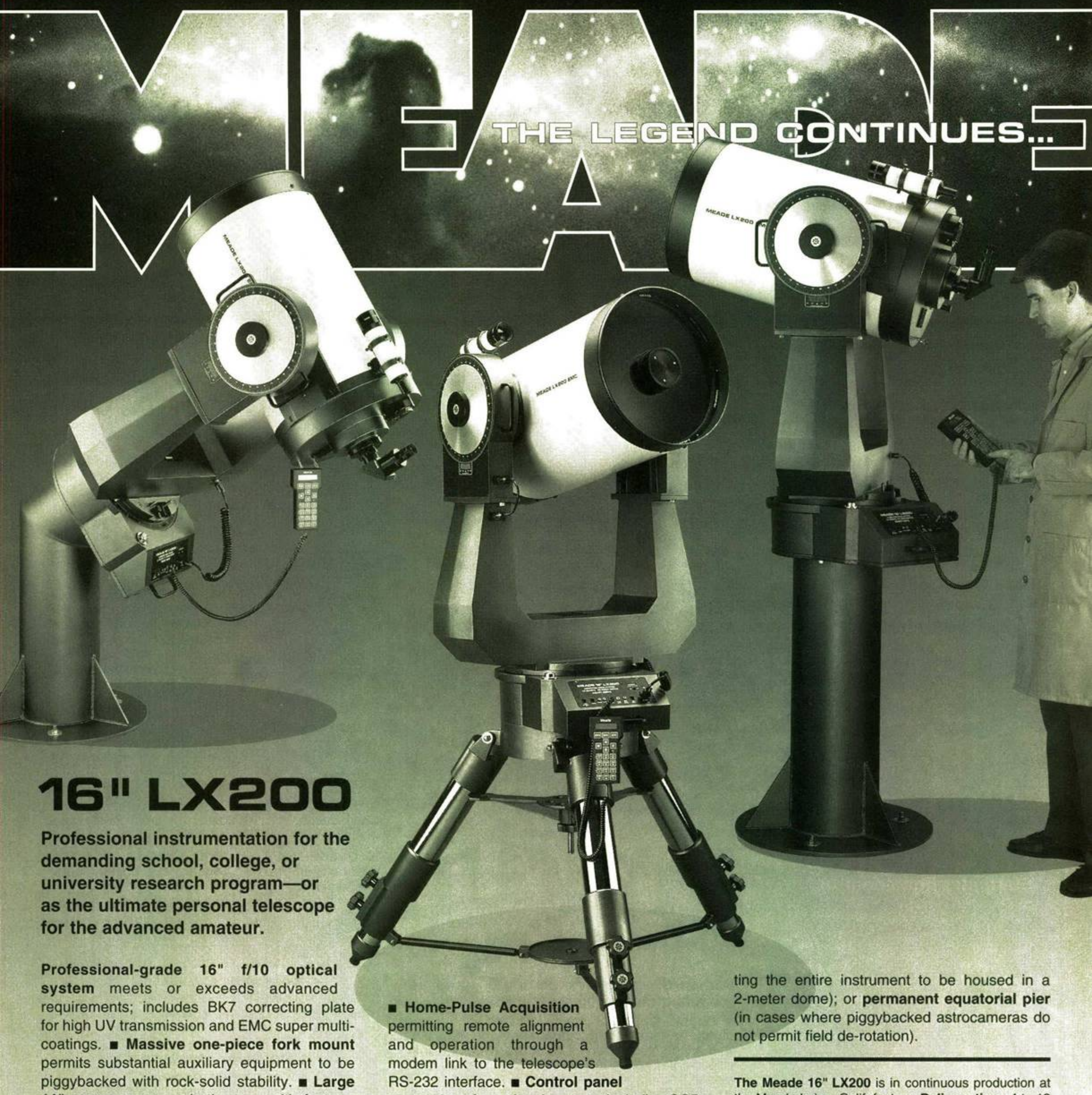

16" LX200

Professional instrumentation for the demanding school, college, or university research program—or as the ultimate personal telescope for the advanced amateur.

Professional-grade 16" f/10 optical system meets or exceeds advanced requirements; includes BK7 correcting plate for high UV transmission and EMC super multi-coatings. ■ **Massive one-piece fork mount** permits substantial auxiliary equipment to be piggybacked with rock-solid stability. ■ **Large 11" worm gears** on both axes, with factory-programmed Smart Drive™; periodic error less than 5 arc seconds. ■ **Automatic GO TO capability** to any object in the onboard 64,350-object database or to any input R.A. and Dec. ■ **High-Precision Pointing**™ to within one arc-minute in the GO TO mode. ■ **DC servo drive systems** with integrated encoders and planetary gearboxes; encoder resolution: 0.13 arc secs. ■ **Six pushbutton-controlled drive-speed rates,** from photo-guide to fast-slew on both axes, simultaneously. ■ **Microprocessor controlled sidereal-rate tracking** in AZ or EQ modes with quartz accuracy. ■ **Home-Pulse Acquisition** permitting remote alignment and operation through a modem link to the telescope's RS-232 interface. ■ **Control panel connectors** for optional systems including CCD autoguiders and imagers, electric focuser, and the Meade **#1222 Field De-rotater** for long-exposure astrophotography in the AZ mode. ■ Available with **supergiant transportable field tripod** (2-person field set-up in less than 10 minutes); **permanent altazimuth pier** (permitting the entire instrument to be housed in a 2-meter dome); or **permanent equatorial pier** (in cases where piggybacked astrocameras do not permit field de-rotation).

The Meade 16" LX200 is in continuous production at the Meade Irvine, Calif. factory. **Delivery time:** 4 to 12 weeks, depending on order status. **Price:** $14,950, complete with supergiant field tripod, plus $385 packing and shipping in the 48 states; prices slightly higher with permanent altazimuth or equatorial pier.

For your copy of the all-new **1995 Meade General Catalog** ($3.00), write Meade Instruments or contact your authorized Meade Advanced Products Dealer.

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Series 4000™ Super Plössls

Meade 4-element Super Plössls, updated and redesigned to utilize the latest in optical glass-types for 1994, are the finest general-purpose eyepieces available. For observing hairline lunar and planetary detail, splitting close doubles, or for deep-space; guaranteed to deliver more contrast and image sharpness than any other brand. Rubber eyeguards fold down for eyeglass wearers–a feature not available on competing brands. Multi-coated. All focal lengths through 32mm are parfocal.

Super Plössls (SP; 4-elements; 1.25"; 52°):

6.4, 9.7, 12.4, 15, 20, 26mm each: **$87.95** (3.45)

32mm (52°); **40mm** (44°) each: **109.95** (3.79)

56mm (52°; 2") **229.95** (5.48)

Series 4000™ f/6.3 Focal Reducer/ Field Flattener

Manufactured to exclusive Meade optical designs; threads on to any Meade or Celestron Schmidt-Cassegrain rear cell and converts f/10 scopes to f/6.3 (or f/6.3 SCT's to f/4), while significantly flattening the field. Use with SCT visual or photo accessories. Actual visual field is increased by 56%, for fine wide-field views of star fields and nebulae. In astrophotography, reduces exposure times by about 50%, while producing an actual field diameter of 1.5° at the film plane. A tremendous aid with CCD imagers in reducing image size for locating and centering images on CCD chips. 4-element optics; multi-coated; 41mm clear aperture.

$129.95 (3.60)

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Through August 31, 1995, Save 10% on Meade Research-Quality Barlow Lenses.

#140: Series 4000 2x Apochromatic Barlow Lens
Regular: $79.95
Sale Price: $71.95

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Regular: $47.95
Sale Price: $42.95

#127: 2x-3x Variable Barlow Lens
Regular: $59.95
Sale Price: $53.95

#126: 2x Short-Focus Barlow Lens
Regular: $47.95
Sale Price: $42.95

This special offer is valid between May 20, 1995, and August 31, 1995, at participating Meade dealers in the U.S.A. and is subject to product availability. Suggested shipping/handling charges shown under detailed product listings in this ad.

Series 4000™ Super Wide Angle

For exquisite wide-angle images at low-to-medium powers, ideal for star fields, galaxies, and other deep-space phenomena. SWA 13.8, 18, and 24.5mm are superb complements to the #140 Barlow.

Super Wide Angle (SWA; 6-elements; 1.25"; 67°)–**13.8mm: $159.95** (3.49); **18mm: 169.95** (3.69); **24.5mm: 199.95** (3.89); **32mm (2"): 279.95** (4.78); **40mm (2"): 339.95** (5.48)

Series 4000™ Ultra Wide Angle

The ultimate eyepieces; extreme image sharpness over an amazing 84° field.

Ultra Wide Angle (UWA; 8-elements; 1.25"; 84°)–**4.7mm: $179.95** (3.29); **6.7mm: 219.95** (3.29); **8.8mm** (1.25"/2"): **269.95** (4.78); **14mm** (1.25"/2"): **329.95** (5.48)

Series 4000™ #140 2x Apochromatic Barlow Lens

The most advanced Barlow Lens available for commercial telescopes; includes 3-element, air-spaced optics, multi-coated. Unmatched in image resolution, contrast and color correction. Accepts 1.25" eyepieces. Lens dia. 28mm; clear aperture 26mm.

$79.95 (3.29)

Series 3000™ Plössls

The very latest in eyepieces from Meade optical designers, new Meade Series 3000 Plössls yield the finest image corrections obtainable from the classical 4-element Plössl design. Available in a wide range of focal lengths from 5mm through 25mm. All five eyepieces are parfocal, so that, at most, only slight refocusing of the image is necessary from eyepiece to eyepiece. Unlike competing moderately-priced Plössls, Meade Series 3000's are **multi-coated** for maximum light transmission and image contrast. Chrome-plated brass barrels are threaded for standard filters. Manufactured exclusively for Meade Instruments by one of Japan's leading lensmakers, Series 3000 Plössls produce excellent results on reflectors, refractors, and Schmidt-Cassegrains of any focal ratio.

Series 3000 Plössls (4-elements; 1.25"; 50°)

5, 6.7, 9.5, 16, 25mm each: **$57.95** (3.45) **Any 2: $52.95** each; **Any 3: $48.95** each; **Any 4 or 5: $46.95** each.

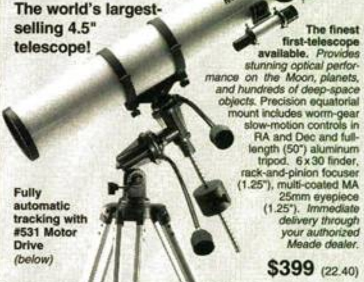
Series 3000™ Plössl 40mm

A perfect complement to the Series 3000 Plössls at left, this all-new Plössl 40mm produces spectacular low-power, wide-field results with any telescope. Includes classical 4-element Plössl optics, multi-coated. Barrel dia. 1.25"; threaded for filters. Apparent field: 44°.

$79.95 (3.79)

Meade Model 4500: 4.5" f/8 Equatorial Reflector

The world's largest-selling 4.5" telescope!



The finest first-telescope available. *Provides stunning optical performance on the Moon, planets, and hundreds of deep-space objects.* Precision equatorial mount includes worm-gear slow-motion controls in RA and Dec and full-length (50") aluminum tripod. 6 x 30 finder, rack-and-pinion focuser (1.25"), multi-coated MA 25mm eyepiece (1.25"). *Immediate delivery through your authorized Meade dealer.*

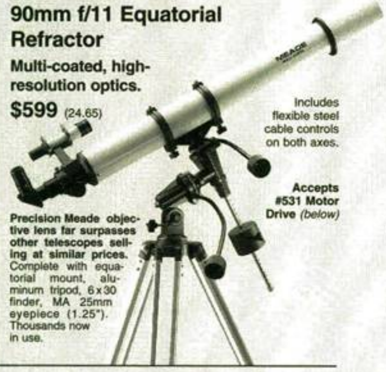
Fully automatic tracking with #531 Motor Drive *(below)*

$399 (22.40)

Meade Model 395: 90mm f/11 Equatorial Refractor

Multi-coated, high-resolution optics.

$599 (24.65)

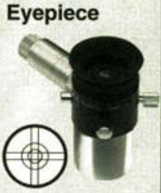


Includes flexible steel cable controls on both axes.

Accepts #531 Motor Drive *(below)*

Precision Meade objective lens far surpasses other telescopes selling at similar prices. Complete with equatorial mount, aluminum tripod, 6 x 30 finder, MA 25mm eyepiece (1.25"). Thousands now in use.

World's Most Advanced Illuminated Reticle Eyepiece



Series 4000 Plössl 9mm, with rubber eyecup and micrometric X-Y positioning of the reticle within the field. Greatly facilitates locking on the guide star. Sharp high-power imaging, excellent eye relief. Wireless red LED illuminator with adjustable brightness control. **Internal batteries included.** Multi-coated optics. Bullseye reticle. 1.25"

$149.95 (3.45)

Series 4000 Plössl 9mm—Same as above but with 6 ft. cord and plug for Meade LX3, LX5, LX6, LX100, LX200, and APO power panels, in place of wireless illuminator.

$129.95 (3.45)

MA 12mm Illuminated Reticle Eyepiece

Excellent 3-element optical system, long eye relief, fully coated, with double crossline reticle. Wireless red LED illuminator and variable brightness control. **Batteries included.**

$99.95 (3.45)

MA 12mm—Same as above but with cord and plug for Meade telescopes with power panels, in place of wireless illuminator.

$79.95 (3.45)

Modified Achromatic Eyepieces

Meade 3-element MA eyepieces yield sharp, well-corrected images on the Moon, planets, and deep-space at a reasonable price. Multi-coated; threaded for filters; 1.25" barrel diameter. Apparent field: 40°. **MA 9, 12, 25, 40mm.**

each: **$37.95** (2.98)

Camera Adapters (1.25" & .965")

Professional-quality adapters for rigid coupling of telescope-to-camera. Use for either Eyepiece-Projection or Prime Focus. Precision-machined of aluminum and brass, threaded for filters. Use with T-mount, available separately.

.965": $27.95 (2.98) **1.25": $29.95** (2.98)

Variable-Projection Camera Adapter (1.25")

Machined sliding cell allows variable projection power in eyepiece-projection photography; permits precise selection of correct photo power in lunar and planetary photography; threaded for filters. Use with T-mount for your camera.

$39.95 (2.98)

Tele-Extenders

For Eyepiece-Projection photography with any Meade or Celestron SCT. Threads on to any eyepiece-holder. Use with T-mount for your camera.

Basic Tele-Extender: *(above)* Fixed projection power; use with eyepiece for lunar and planetary photos.

$29.95 (2.98)

Variable Tele-Extender: Sliding cell, with lock, permits wide range of projection magnifications with the same eyepiece.

$39.95 (2.98)

T-Adapters for SCT's

For Prime Focus photography with any Meade or Celestron SCT. Use with T-Mount for your 35mm camera.

$26.95 (2.98)

#531 Motor Drive

Attaches in seconds to the equatorial mounts of Meade Model 4500 or 395 telescopes. Permits fully automatic tracking of celestial objects. Cordless operation anywhere in the world from 3 (user-supplied) AA batteries. **$99.50** (4.78)

2x Telenegative Barlow (1.25")

#122: Doubles eyepiece power with sharp, high-resolution, high-contrast imaging on telescopes of all types. 27mm dia. (26mm clear aperture). Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multi-coated. 1.25"

$47.95 (3.45)

2x-3x Variable Barlow (1.25")

#127: Precision internal sliding lens assembly permits continuously variable power settings between 2x and 3x. Engraved scale indicates power in use. Yields bright, sharp, high-contrast images on telescopes of all types. Multi-coated; 1.25".

$59.95 (3.45)

2x Short-Focus Barlow (1.25")

#126: Only 2.5" long, the #126 works well with any telescope accepting 1.25" eyepieces, even those with limited focus range. Maintains the high image quality of the #122, above. Insert the #126 into star diagonal for 2x or insert star diagonal into #126 for 3x. 26mm clear aperture. Multi-coated.

$47.95 (3.45)

HOW TO ORDER

- Prices shown are suggested USA mail-order retail prices and do not include any applicable sales taxes.
- Suggested shipping and handling charges to the 48 states by UPS or US Mail shown in ( ) next to each price.
- Meade accessories may be ordered from any Meade Advanced Products Dealer. **The following national mail-order dealers carry all Meade accessories in-stock for immediate shipment:**

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

CALIFORNIA TELESCOPE CO., Burbank, CA.
Orders: 800-843-4780; Info.: 818-505-8424.

CITY CAMERA, Dearborn, MI.
Orders: 800-359-5085; Info.: 313-846-3922.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828; Info.: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-767-9576; Info.: 510-447-9570.

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders: 800-621-2248; Info/IL: 312-332-2000.

Canada:

EFSTONSCIENCE, Toronto, Ontario.
Orders & Information: 416-787-4581.

KHAN SCOPE CENTRE, Toronto, Ontario.
Orders & Information: 416-783-4140.

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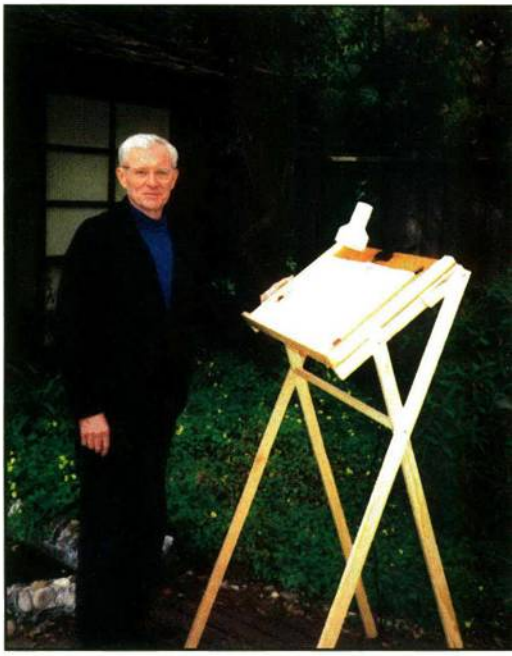
pole star — that will occur in the 21st century. In Egyptian times, Thuban in the tail of Draco served as pole star. In the long intervening times there has been no such convenient marker, but the clever Mayans were still able to recognize the functioning of a pivotal point in the north without the presence of a star. — *Stephen Eberhart, Reseda, California*

Easy Easel

After years of clumsy observing sessions that had me stuffing eyepieces into my pockets and juggling a star atlas, a viewing program, and a red-lens flashlight, I finally did something about it. I built a tall, portable easel and equipped it with a red light. I also drilled 1¼" holes into the sides for extra oculars.

Why didn't I think of this years ago? — *Rev. James Brice Clark, Woodland, California*



A PORTABLE EASEL keeps Rev. James Brice Clark organized while observing.

No Telescope Required

It was refreshing to read "Glows, Bands, and Curtains" by John Shibley (April 1995). The article reawakened my memory of the grand auroral displays of 1991, many of which I captured on film.

I also appreciate the nice explanation of a celestial show whose rather unpre-

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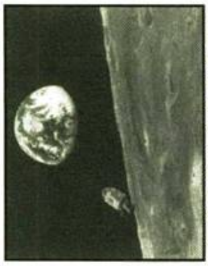

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dictable and exciting performance requires no optical aid. — *Randall Wehler, Willmar, Minnesota*

I agree with Lynn Erny's letter "Back to the Basics" (March 1995). Even though I think telescopes are unequaled in viewing some objects, my 20x80 and 10x50 binoculars offer a wide 3.3° and 7.0° field of view and gather 50 to 100 times more light than the naked eye. A reasonably priced pair of binoculars and a sturdy tripod will provide great views of M44, M45, M41, and M8 to name only a few. — *Tom L. Ingram, Fayetteville, Tennessee*

How I Overcame My Problem

Thanks for the review of Astro-Systems' Laser Collimator (April 1995). After reading it, I realized that I've had three problems trying to see planets with my 12.5-inch Dobsonian: lousy viewing conditions, too much light pollution, and inadequate collimation. I have since overcome these challenges, and so far image improvement has been dramatic. Sincerest thanks. — *Bill McCall*

Twelve Splendid Spirals

Hey, go easy on the CCD images. When I saw the photos in "Twelve Splendid Spirals," I had to write.

It seems like these blurry, psychedelic pictures with little square stars are taking over your fine publication. I appreciate the valuable contribution CCDs make to the world of astronomy, and I'm sure auto-guiding is a welcome relief to those who have spent countless hours hunched over an eyepiece. But surely you could have used film images of these splendid objects, such as the fantastic shot of M33 on page 71.

I look forward each month to the sharp, detailed photographs of the most awesome objects in the sky that only film and patience can provide. Don't let the hi-tech, computer-doctored images take over your magazine. — *Scott Underwood, Aurora, Colorado*

Need Your Help

We are seeking information about legal cases using significant astronomical evidence for a planetarium show now being developed. If you know of any (other than those involving Abraham Lincoln), please write to Norman Sperling, Planetarium Coordinator, Chabot Observatory and Science Center, 4917 Mountain Boulevard, Oakland, CA 94619.

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#140 2x 1.25"	72
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Carrying case	80
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Dust caps	call
Dec 55	78
Drive 43 110v-12v	129
Drive 47M (6-8-10)	429
Drive 48RS (16")	499

Meade Accy's:	
Accy case 50	$67
Car cord LX200	85
Diagonal 1.25"	42
Diagonal .96-1.25"	28
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Diagonal 1.25" 45°	53
Diagonal 929 2"	100
EP holder 1.25"	25
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Focuser 680 2"	100
Focuser 682 2"	100
Finder 8x50	70
Finder 634-6x30	50
Filter set of 4	55

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Filter set of 12	145
Filter ND96 1.25"	18
Illum 12mm w/cord	80
Illum 12mm-wless	100
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Illum 9mm-wless	150
Lenshood 8"	114
Lenshood 10"	124
Lenshood 12"	174
Nebula 908B	80
Nebula 908N	90
Nebula 911B	100
Nebula 911N	120

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Piggy brkt 12"	49
Reducer f:6.3	130
Skylight/seal	48
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Tele ext-variable	40
T-adapt: vari-proj	40
Vari pol 905	50
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Weight set 10"	90
Weight set 12"	100
Wedge 8"	134
Wedge 10" Super	395

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SP56mm	230
Super Wide 13.8	160
Super Wide 18	170
Super Wide 24.5	199
Super Wide 32	280
Super Wide 40	340
Ultra Wide 4.7	180
Ultra Wide 6.7	220
Ultra Wide 8.8	270
Ultra Wide 14	330

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20mm Type2	368

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15mm	132
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Paracorr 2"	228

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22mm	269
27mm	319
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1.8x	84
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a nearside lunar feature after French astronomer and hydrographer Pierre Francois André Méchain (1744-1804). Méchain made many eclipse observations, discovered several comets, and found 28 of the 110 objects listed in Messier's catalogue of nebulae and star clusters. Because Méchain was an accomplished mathematician with the French government, Messier relied on him to calculate comet orbits and object positions.

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In 1791, Méchain was to be the leader of the southern survey team that measured the meridian arc from Barcelona to Dunkirk. The measurements were used to establish the length of the meter.

To help me commemorate Méchain for his work, I am calling on all astronomers to write to the International Astronomical Union requesting that they add his name to the official lunar nomenclature list for nearside features. Send your letter to Dr. V. V. Shevchenko, Lunar Task Force, Sternberg State Astronomical Institute, Moscow University, 13 Universitetsky Prospekt, 119899 Moscow, Russia. Please send me a copy of your letter. — *Robert Garfinkle, 32924 Monrovia Street, Union City, California, 94587.*

Eyepiece Returned

I wanted to update you on the situation concerning the eyepiece stolen at The Connecticut Star Party (Letters, May 1995). It was returned last week. What a tremendous relief to the star party organizers and to the individual from whom it was stolen. — *Al Washburn, The Astronomical Society of New Haven, Inc., New Haven Connecticut* ☐

ASTRONOMY welcomes feedback. Send comments to ASTRONOMY Letters, P.O. Box 1612, Waukesha, WI 53187, or use letters@astronomy.com on the Internet. Letters may be edited.

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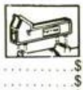

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ASTRO FORUM

Do We Need Organized Astronomy?

by Gordon Bond

Flip through the pages of ASTRONOMY from twenty years ago and I'll guarantee you won't see any Dobsonians, CCDs, computers, or nebular filters. Armed with these advances over the intervening years, deep-sky observers routinely observe deep-sky objects common wisdom once considered impossible for the amateur.

The National Deep Sky Observers Society, which will celebrate its twentieth anniversary next year, has born witness to these changes. Many of today's deep-sky zealots blaze out on their own and spend big bucks on telescopes, eyepieces, computer programs, databases, atlases, and so on. In this age of sophisticated gear and ready information, is there really a role for organized astronomy in today's world? Are special-interest groups like NDSOS doomed to die as their membership grays with age?

To get a handle on this question, I decided to poll a number of NDSOS members, many of whom live in other countries. I started by asking if enthusiasts preferred membership in astronomical organizations. The answer seems to depend on what country they live in.

Conventional wisdom holds that American observers are "loners" while Canadian amateurs are more "joiners." While the Royal Astronomical Society of Canada (RASC) enjoys widespread popularity through metropolitan outlets called "centres," American amateurs tend to gravitate more toward local clubs. Americans do join, they just do it at a local level through neighborhood astronomy clubs and regional star parties.

European amateurs tend to congregate within their national boundaries and, at first glance, seem to do more sophisticated work. But a European's way of doing organized astronomy (which, in turn, leads to the impression that it's advanced) is dictated by economic reality rather than nationalism.

For the most part, Europeans see American amateur astronomers as being blessed by a vast selection of equipment and information. Compared to other countries, Americans also have a greater level of disposable income to spend on astronomy. These two factors, many feel, contribute to the relative ease with which Americans can obtain the tools for their hobby. Because of this, the United States has a huge community of people with only a casual interest in astronomy. Buying a scope on the whim of wanting to see a comet is not unknown.

By contrast, in even the more industrialized European nations, equipment is far more scarce. When equipment is available, its cost can make getting into the hobby very prohibitive. As a result, only people who are really serious about astronomy can afford to buy a quality telescope and accessories. This results in an apparent lack of amateur astronomers, strung within a framework of national societies or international organizations such as NDSOS. In many cases, these groups provide the only opportunity for observers to contact one another.

"As an observer, I am a lonely rider," says Petteri Rajanen, a 29-year-old NDSOS member from Tampere, Finland. "I think many observers are individualists and don't need anyone to tell them what to do or observe — I certainly am. I do my own projects and observing programs. But I certainly want to know what other advanced observers do and to hear of new interesting objects."

European observing clubs also fill a void when it comes to communicating astronomy. While the United States has

Petteri Rajanen

FINNISH OBSERVER Petteri Rajanen with his telescope.

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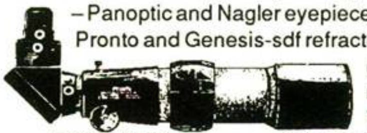
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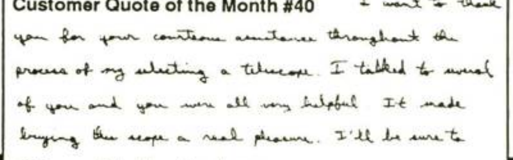
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3.1"	52.00	3.1"	42.00
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6"	79.00	6"	69.00
8"	95.00	8"	85.00
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3.5" to 4"	76.00	3.5 to 4"	66.00
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6"	105.00	6"	95.00
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two glossy commercial astronomy magazines, national club journals are often the only periodicals easily available to Europeans. The Czech Republic, Hungary, Sweden, and Finland, to name a few, have some impressive national publications thanks to the efforts of their amateur community.

These special-interest journals give many Americans the erroneous impression that, for the most part, European amateurs are more sophisticated. Truth is, America probably has the same number of hard-core observers, but they're outnumbered by a larger number of casual observers.

But no matter how serious observers are about their hobby, it's a universal struggle to keep organizations active.

According to French NDSOS member Yann Pothier, French astronomy groups are no different from other clubs in that regard. The problem is getting and keeping members interested in common projects.

"Of course the people in charge do their best to galvanize," says Pothier. "When they get weary of the surrounding disinterest, they are prone to giving up the attempt."

He sees the same "lone rider" factor at work in French clubs that Rajanen mentions.

"This probably arises from the solitary nature of the astronomer's passion," he says. "Most of us, at least here in France, started alone before joining a group."

But Pothier also sees a deeper cultural reason for this lack of eagerness to get involved in organized astronomy. "Its probably linked to the main nature of leisure activities in our society," he notes. "Leisure time is considered unproductive and as sheer consumerism. The typical 'astro-consumer' pays his subscription rate to become a club member and therefore expects to get some return without giving anything more besides his money."

Pothier's attitudes were a bit different when he joined the NDSOS: "I was paying to have the right to participate and did so as soon as I could. According to my abilities in deep-sky observing at the time, I submitted several observations and articles without being afraid of displaying a lack of expertise. That remains my way of helping the NDSOS operate."

It boils down to the reality that a hobby only amounts to the time that's put into it. "Sometimes I feel that I have

Star trails over Texas

ASTRONOMY: John Shibley

to do almost everything," says Alan Goldstein, an Indiana deep-sky observer and a founder of NDSOS. "Especially when eager volunteers suddenly disappear after they agree to lead a project."

But where do they disappear to? The answer, Goldstein admits, may be found in changing commitments. When he started the NDSOS twenty years ago, Goldstein was an eager teenager. Hours once free to indulge in amateur astronomy have given way to the shifting priorities of a family and full-time job. It's been the same for many who are of the same generation.

Canadian Alister Ling, a meteorologist from Edmonton, Canada, is a former NDSOS member, who dropped from the scene.

"I've cut back because of time, or lack thereof. People have less spare time now than they did 20 years ago. They have families, other hobbies," he says. "I've cut back a lot on astronomy because I am spending time with my wife and daughter. I can't drop astronomy completely because it is who I am, so I am doing what I enjoy most — observing and cataloging what I see."

So regardless of national boundaries, priorities change with time and things once central to life during youth can become secondary later on. As Ling asks, "Where have all the 16- to 30-year-old single people gone? Only they have the energy and time to devote themselves that much. I should know, I was one!"

So whence come the "next generation" of deep-sky observers? Perhaps in this high-tech age, organizations such as the NDSOS can play an important role by supporting and encouraging the next generation, be they "joiner" Canadians, "regional" Europeans, or "loner" Americans. Organized astronomy provides a forum where the "old guard" can pass on experience and knowledge to the next generation — come what may over the next 20 years. ☐

Gordon Bond edits the NDSOS journal The Practical Observer *and observes the universe from Middlesex, New Jersey.*

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ASTRO NEWS

And PSR 0329+54 Makes Three

By detecting a 17.7-millisecond delay in the rhythmic pulse from a pulsar 4,700 light-years away in Perseus, a Russian astronomer has deduced its system may harbor one or possibly two planets. Tatiana V. Shabanova of the P. N. Lebedev Physical Institute in Moscow announced her findings at the American Astronomical Society meeting held in Tucson last January.

Shabanova looked at data collected on pulsar PSR 0329+54 by the Russia's Pushchino Radio Observatory in Russia between 1978 and 1994. She also surveyed data compiled at the Jet Propulsion Laboratory between 1968 and 1983 using NASA's network of spacecraft tracking antennas. The rapidly spinning pulsar, the core of a star that went supernova thousands of years ago, sends out an energy pulse every 0.714 second.

She scrutinized the data for changes in the arrival times of pulses, which would betray the gravitational tug of unseen companions. After measuring a 0.0177-second delay, Shabanova calculated PSR 0329+54 has a planet twice as massive as Earth that orbits at a distance of seven times the Sun-Earth separation, taking 16.9 years to complete one orbit.

But even after accounting for the new planet, tiny but detectable delays in the Pushchino data suggest there might be a second planet one-third the mass of Earth orbiting at slightly more than twice the Earth-Sun distance. Because this evidence isn't in the JPL data, Shabanova says more observations are needed to confirm this finding. But for now, PSR 0329+54 joins an exclusive club of three pulsars that have planets around them (see "Lost and Found: Pulsar Planets," June 1992).

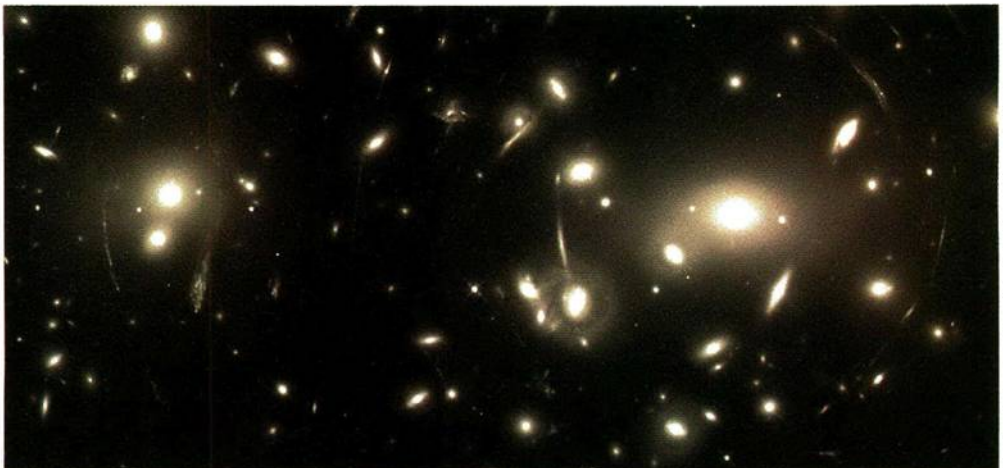
U.S. Gemini Project Office

BALANCED ON TOP of its form, the 8-meter mirror for one of the twin Gemini scopes being built in Hawaii and Chile was ready for shaping in February. Corning engineers heated the mirror, which then sagged over the form and assumed a curved shape. Opticians will now trim the edges of the mirror, cut a hole in the center, and grind both sides of the mirror to their final curvature. They will finish these steps in November and then ship the mirror to REOSC Optique in France for surface polishing.

Not So Fast. . .

The ongoing debate over the size and age of the universe has taken another turn. A team of theorists now suggests the universe is much older, and is expanding much more slowly, than indicated by the recent Hubble Space Telescope measurements of the Virgo Cluster of galaxies (see "How Far to Virgo?" March 1995). The group, which includes Joseph Silk of the University of California, Berkeley, and Michael Turner of Fermilab in Batavia, Illinois, claims that the Hubble constant, a measure of the expansion rate of the universe, is 30 kilometers per second per megaparsec. This figure is one of the lowest Hubble constant values ever proposed, and is less than half of that claimed by the HST researchers.

Instead of directly measuring the Hubble constant, the cosmologists reviewed a variety of observations and models, as reported in the February 17, 1995, issue of *Science*. They were looking to see what Hubble constant value would best tie together the age of the oldest stars with the evolution of the universe. For instance, they note that the ages of the oldest


W. Couch, Univ. of New South Wales, et al., and NASA

A COSMIC LENS of giant proportions forms more than 100 arcs across the cluster of galaxies called Abell 2218. The gravity of the galaxy cluster is bending the light of distant galaxies that lie five to 10 times farther away than the cluster. Faint arclets represent galaxies that are 50 times fainter than objects observable with ground-based scopes. A team of astronomers is using this image taken with the Wide Field and Planetary Camera 2 on the Hubble Space Telescope to study the nature of galaxies in the early history of the universe.

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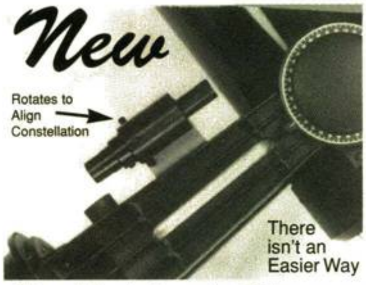

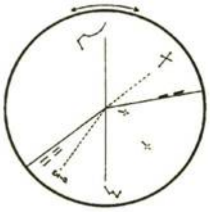

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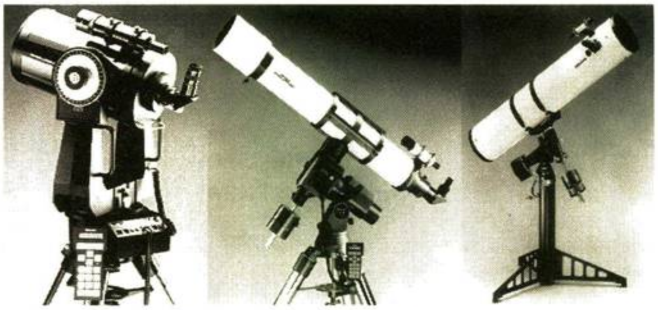

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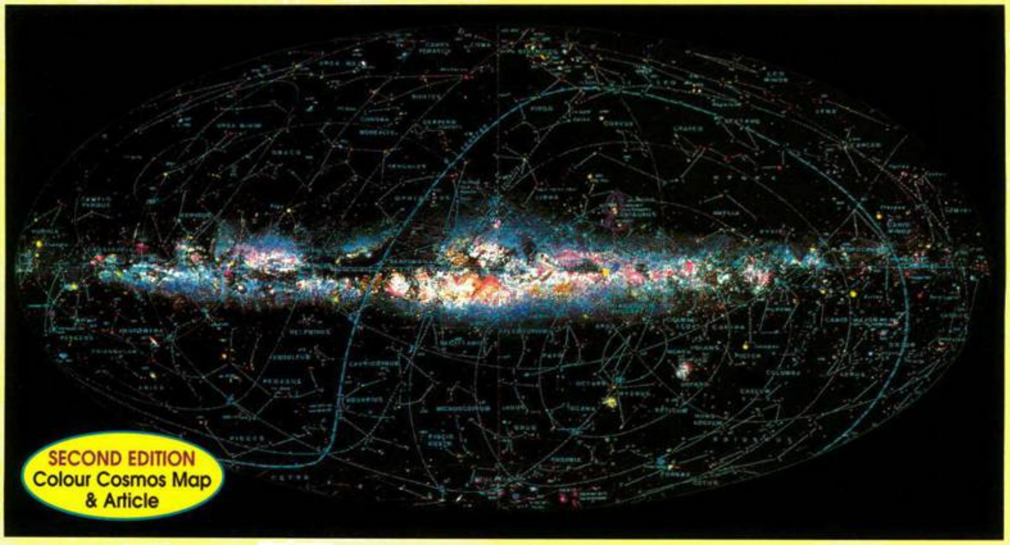

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stars and very distant red (and thus ancient) galaxies all indicate that the universe must certainly be older than 12 billion years. These ages alone require a much lower Hubble constant than the one calculated from the Virgo galaxy measurement.

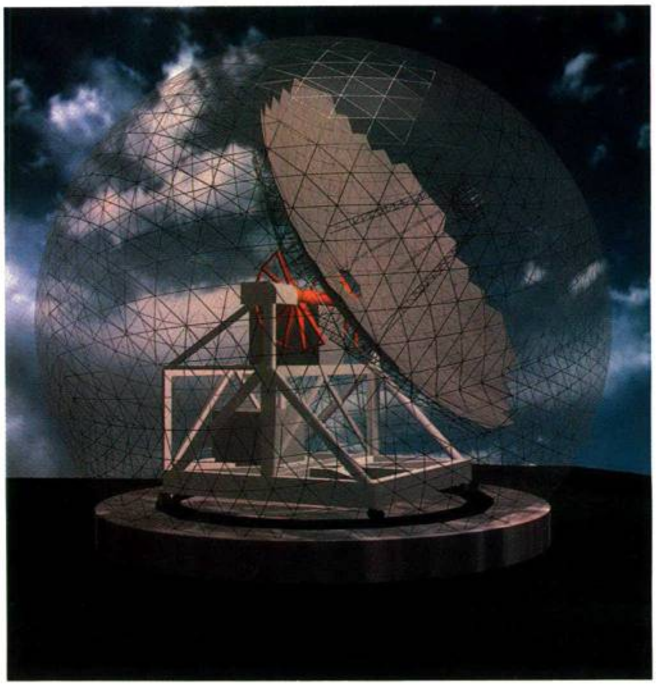
The theorists also note that the cold dark matter model has serious problems when combined with a high Hubble constant. Cold dark matter is one of the most favored theories for explaining how the universe evolved into the clusters, sheets, and walls of galaxies that astronomers now observe. But Silk and Turner contend the marriage of cold dark matter with a high Hubble constant can't explain small variations in the cosmic background radiation, the abundance of X-ray clusters, or the large-scale structure of the universe as presently observed. They argue, however, that by simply using their low Hubble constant in the cold dark matter model, the problems appear to be resolved.

The theorists also question the reliability of Cepheid variables and type II supernovae, long used as "standard candles" to measure the distances to galaxies, and hence determine the Hubble constant (see "Candles to Light the Night," September 1994). They argue that underlying assumptions and potential errors in these techniques might be skewing the results and leading to the wrong conclusions.

While the Silk-Turner team appears to be favoring theory over what most astronomers agree is the most accurate direct measurement of the Hubble constant, they concede, "Ultimately, the value of the Hubble constant will be determined by measurements and not the wishes of theorists."
— Robert Zimmerman

GONG, NOAO

GONG! The first station of the Global Oscillation Network Group (GONG) at El Teide Observatory on Tenerife, an island in the Canaries, became operational in January. One of six stations in the network, it will monitor surface motions and magnetic fields on the Sun. These observations will enable solar astronomers to peer deep into the Sun's interior (see "Journey to the Heart of the Sun," January 1995). The Learmonth, Australia, station started making observations in April. The remaining stations on Mauna Loa in Hawaii, Cerro Tololo in Chile, Udaipur in India, and Big Bear in Southern California will join the first two by early autumn.



INAOE

THE ORIGIN OF THE UNIVERSE, interstellar clouds, and star formation will be areas of research for this 50-meter telescope being built in Mexico for U.S. and Mexican astronomers.

Giant Mexican Telescope

A joint effort of Mexico and the United States, the Large Millimeter Telescope will be fully steerable and will have the highest sensitivity of any telescope operating at millimeter wavelengths. The 50-meter-diameter scope will be located in Mexico, giving it a good view of both hemispheres. The University of Massachusetts leads the U.S. group and the Instituto Nacional de Astrofisica, Optica y Electronica in Puebla leads the group in Mexico.

Although testing of several sites is underway to determine the best location for the scope, it will sit at an altitude of at least 9,000 feet to get above water vapor in Earth's atmosphere. Water vapor reduces the ability of millimeter scopes to see short-wavelength radiation.

The scope has some novel design concepts. It uses a segmented reflector like the mirror of the 10-meter Keck telescope. An active control system will keep each segment properly aligned as the dish moves. Instead of a metal dome, the scope will have a fabric-covered radome like those housing radars. The radome, which is transparent to millimeter waves, always covers the scope and shields it from wind, making it easier to aim the large dish.

Intergalactic Carbon

Compared to the space between stars in the Milky Way Galaxy, the space between galaxies is nearly empty. But in the 1960s astronomers discovered clouds of hydrogen in intergalactic space. In 1994 they found helium. Recently they identified a third and heftier denizen of the intergalactic wilderness: ionized carbon.

A team of University of Hawaii astronomers, led by Lennox Cowie and Antoinette Songaila, discovered the carbon by pointing the 10-meter Keck Telescope at three distant quasars. The carbon showed up as a series of gaps in the quasars' spectra. The researchers in-

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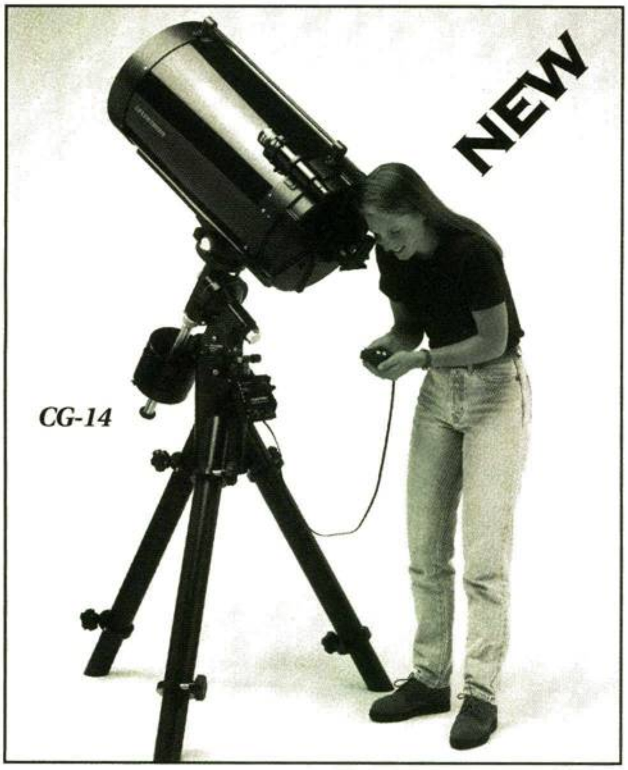

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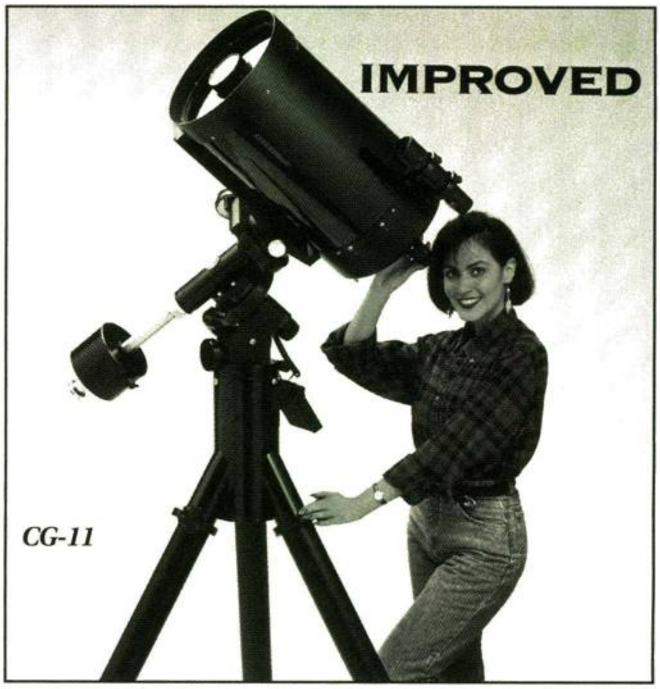

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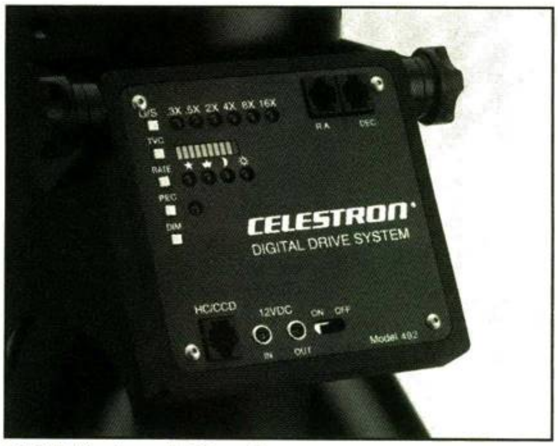

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terpret the gaps as being light from the quasars absorbed en route by carbon atoms floating in intergalactic space.

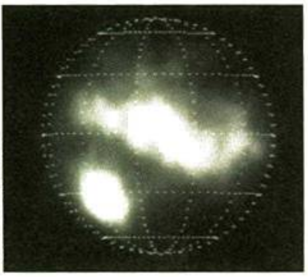
Because the Big Bang didn't create elements as heavy as carbon, the presence of this element in the intergalactic realm hints that a generation of stars populated the universe even before the first galaxies formed. These first-generation stars flickered to life perhaps one billion years after the Big Bang and were 10 to 100 times more massive than the Sun. They forged carbon in their cores and spewed the element into space when they exploded as supernovae.

Despite the enormity of intergalactic space, the newly discovered carbon doesn't

AMATEUR NEWS

Getting to Know Io

Through a program that lets amateur astronomers use the Hubble Space Telescope, amateur Jim Secosky investigated an enigmatic brightening sometimes seen when Jupiter's moon Io leaves the shadow of the giant planet.


Jim Secosky/STScI

SURFACE DETAIL ON IO comes into view in this Hubble Space Telescope image taken by amateur astronomer Jim Secosky, who wanted to capture Io's enhanced brightness due to surface frost. When compared to a Voyager image processed to the same resolution, Secosky's picture reveals large tracts of Io's surface remain unchanged since Voyager's visits in 1979.

Secosky, a high school science teacher from Bloomfield, New York, imaged Io on three occasions in 1992 as it emerged from Jupiter's shadow, using Hubble's Wide Field and Planetary Camera 1 with a ultraviolet filter. The results of his work were published last autumn in the science journal *Icarus*.

In the article, coauthored with Michael Potter of the Space Telescope Science Institute, Secosky reports that his pictures showed no brightening, perhaps due to Io's low level of volcanic activity. Astronomers theorize that sulfur dioxide emitted by volcanoes forms a surface frost when Io passes into Jupiter's shadow. As the moon moves out of eclipse it appears brighter than usual for 15 minutes as the frost vaporizes in sunlight. At the time Secosky took the pictures in 1992, ground-based studies showed that volcanic activity on Io was very low.

California Astroimagers Confab

More than 145 astroimaging enthusiasts gathered last March as the Ventura County Astronomical Society hosted its Astrophoto XI symposium at Moorpark College in Moorpark, California. This year's program covered all aspects of astrophotography, including film selection, telescope selection, image processing, and CCD imaging. Talks dispensed equipment advice and technique tips to novice and advanced astroimagers alike.

Kim Zussman

ASTROPHOTO ENTHUSIASTS soak up some celluloid sights during a break in the talks at Astrophoto XI, held last March in Moorpark, California. Amateurs enjoyed a day of presentations and astrophoto exhibits during the meeting.

For beginners, Hal Jandorf surveyed simple astrophotography using a telescope- or tripod-mounted camera to shoot star trails, constellations, and conjunctions. In the "keep-your-chin-up" vein, Dennis Leatart's humorous talk entitled "Astro-Disasters" showed common errors made by even the most experienced astrophotographers.

Astrophotographic perfection took center stage as Lee Coombs showed how he uses an apochromatic refractor for lunar and planetary photography. He shared excellent images of solar system objects. Deep-sky aficionados were impressed by Tony Hallas and his prototype apochromatic 7-inch f/7 refractor, which he uses for wide-field deep-sky imaging on 6 x 7 cm hypered film. Hallas unveiled a color picture of M31, which may be the best amateur image ever taken of this object.

For the "electronic generation," Bill Fletcher demonstrated how he uses Adobe *Photoshop* to scan, combine, and process tricolored images. Kim Zussman discussed using CCD cameras for long-exposure deep-sky imaging, and presented a technique for determining gain and read noise in the CCD camera. James Foster conveyed his refinements on processing of scanned tricolor images, including the equivalent of digital dodging and masking.

Astrophotographers of the conventional and electronic persuasion now look forward to Astrophoto XII, to be held in March 1996. For more information on that meeting or to order the Astrophoto XI proceedings book for $12, write the Ventura County Astronomical Society, P. O. Box 982, Simi Valley, CA 93062. — *Kim Zussman*

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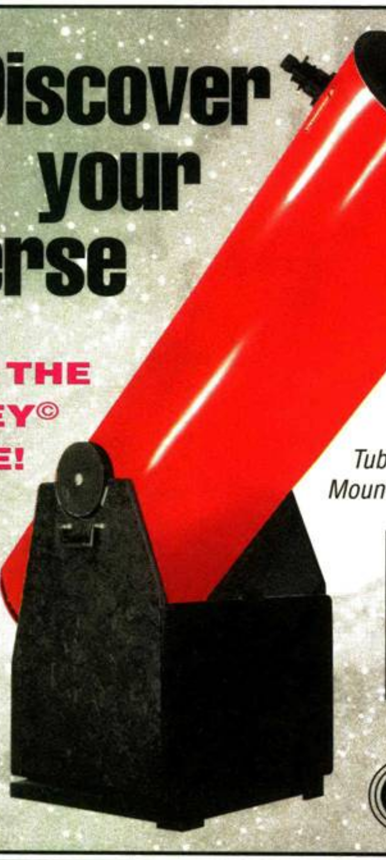

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make much of a dent in the dark-matter problem. The ionized carbon is so rare that it comprises a mere one atom out of a million intergalactic atoms. In contrast, the Sun contains 300 carbon atoms for every million; later supernovae enriched stars like the Sun with carbon. The Hawaii astronomers report their discovery in the April 1995 *Astronomical Journal.*

Young Disks Shed Light on Solar System

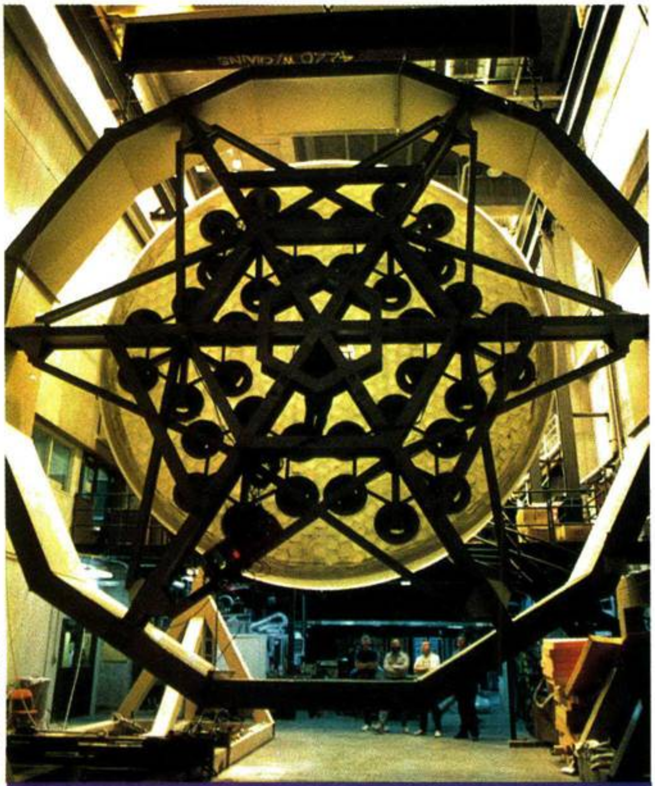
Astronomers have discovered massive, unstable disks of material surrounding some of the youngest stars in our Galaxy. The research by Patrick Hartigan of Rice University, Suzan Edwards of Smith College, and Louma Ghandour of the University of Massachusetts may help clarify how our Sun and its planets formed 4.6 billion years ago.

Many young stars appear to be surrounded by disks of gas and dust that astronomers believe eventually coalesce into planets. When the disks are very young, some of the material spirals inward and crashes onto the surface of the star. The energy released in these impacts allows astronomers to estimate how rapidly matter accretes onto the star.

The present study, announced at the January 1995 meeting of the American Astronomical Society, compared the mass accretion rates of 42 young stars some 450 light-years away in the constellation Taurus. When the observers saw what appeared to be a disk encircling one of these stars, they also found that the inner part of the disk appeared to be falling in toward the star.

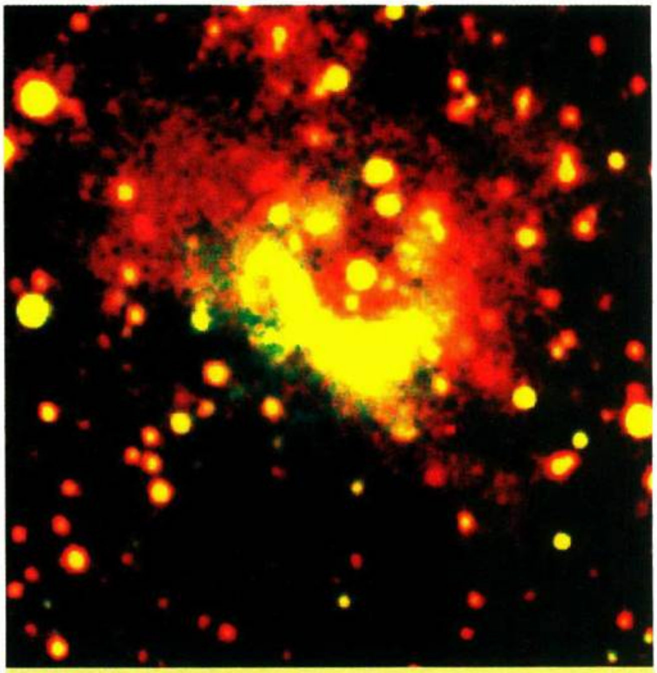
"The youngest stars accrete material the fastest," says Hartigan. "In the most extreme cases, stars swallow the equivalent of several times the mass of the Moon each week, and this feast continues for hundreds of thousands of years."

The new results may help astronomers understand the early history of our solar system. The planets all lie in nearly the same plane, as if they formed from a disk like the ones astronomers observe around young stars. When planets coalesce they should create gaps in the disk. As the gaps grow they eventually encompass the entire disk, and material ceases to fall onto the star. This scenario is what Hartigan and his colleagues are observing over a range of young stars: They find that when the accretion stops, the disks become transparent, and the astronomers believe they probably consist of planets.



University of Arizona

READY FOR POLISHING, the 6.5-meter replacement mirror for the Multiple Mirror Telescope sits in a special cradle in November 1994 while being inspected. The person standing in the cell provides a scale for the large mirror. Cast in the University of Arizona Mirror Lab, the mirror will replace six smaller ones in the Multiple Mirror Telescope located on Mount Hopkins, south of Tucson, Arizona.



Ronald Remillard, MIT

A GIANT GAS CLOUD in the Large Magellanic Cloud, a nearby galaxy, glows from the energy of "soft" X rays (wavelengths around 1 nanometer). A team led by Ronald Remillard of the Massachusetts Institute of Technology took this image in red hydrogen and green oxygen light with the 1.5-meter telescope at Cerro Tololo Inter-American Observatory in Chile. Reported in the February 1, 1995, *Astrophysical Journal*, their study of the cloud, called CAL 83, shows that it contains about 150 times the mass of the Sun and spans about 80 light-years. The source of the X rays may be a white dwarf star burning gas ejected by a companion star.

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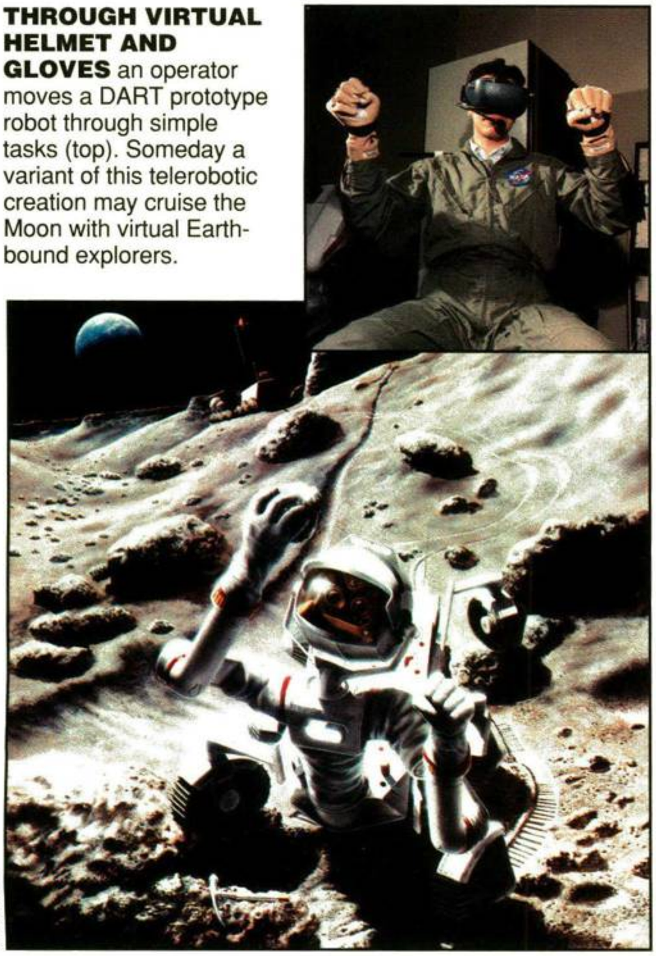
Being (Tele)present

Engineers at NASA's Johnson Spaceflight Center are combining the technologies of virtual reality with robotics. Their effort will someday allow human controllers wearing 3-D viewer helmets and sensor-laden body suits to walk on other planets and the Moon through robot surrogates.

A prototype system, called DART/FITT (for Dexterous Anthropomorphic Robotic Testbed/Full Immersion Telepresence Testbed), lets an operator control a robot through a viewer-helmet and sensor gloves. The helmet presents a 3-D scene from two cameras mounted on the robot, while sensors mounted on the helmet and in the gloves convey the operator's movement to the robot. Through the robot, the operator can grasp objects and perform simple functions.

Still to come: tiny actuators in the gloves to pass on sensations of resistance that the robot feels. Then there's reconciling movements between human and machine. For example, if the operator's arm moves along a course the robot can't follow, it has to translate the movement into an acceptable route. "The physical behavior of the robot and human is generally different," says Project Engineer Larry Li. "[Translating human motion] requires intelligence on the part of the robot, which must make decisions on its own to compensate for the difference."

Cut to the future: Under a jet black lunar sky, geologist's pick in hand, you chip away at a rock outcropping. You hear a muffled ring in your helmet. "Freeze arm," you command, and step to your desk to answer the phone.



THROUGH VIRTUAL HELMET AND GLOVES an operator moves a DART prototype robot through simple tasks (top). Someday a variant of this telerobotic creation may cruise the Moon with virtual Earth-bound explorers.

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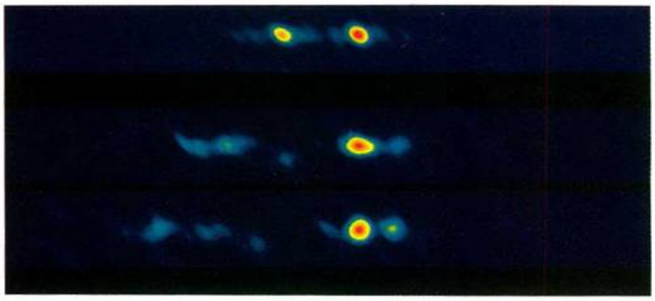

HIGH-SPEED GAS CLOUDS RACE away from the X-ray nova GRO J1655-40 in Scorpius. These VLBA radio images show the rapid motion of the clouds from August 18 to September 22, 1994, with earlier images toward the top and the vertical spacing indicating the relative time that elapsed between images. The bright radio core of the nova appears at the center of each image with the individual blobs moving away at nearly the speed of light.

Robert Hjellming and Michael Rupen (NRAO/AUI)

X-ray Nova Shoots out High-Speed Jets

A mysterious X-ray nova located 10,000 light-years away in Scorpius is ejecting blobs of material at speeds approaching that of light. Recent radio observations show that some of the blobs even appear to be moving faster than the speed of light, an illusion created by their enormous actual speed and their direction of motion relative to Earth.

The nova, discovered on July 27, 1994, by the Compton Gamma-Ray Observatory and designated GRO J1655-40, was imaged at radio wavelengths with the antennas of the Very Long Baseline Array. The ultra-high spatial resolution of the VLBA allowed astronomers to track individual blobs as they raced away from the object's core. The blobs appear to move at speeds ranging from less than 50 percent up to 130 percent the speed of light.

GRO J1655-40 most likely is a binary star system consisting of one fairly normal star and a gravitationally collapsed companion, either a neutron star or black hole with a mass a few times greater than the Sun. The strong gravity of the companion draws material from the normal star, which forms a gaseous accretion disk orbiting the collapsed star. As the material spirals into the collapsed object, it grows hot and releases the X rays observed by Compton. Astronomers think the accretion disk also generates high-speed jets of subatomic particles. During an outburst, denser clouds are ejected that interact with magnetic fields to produce the strong radio emission.

Many active galaxies and quasars produce similar jets, although the central engines in these objects are thought to be black holes with masses millions of times greater than the Sun. By studying in detail GRO J1655–40, astronomers hope to resolve some of the questions that remain about how high-speed jets are produced elsewhere in the universe. □

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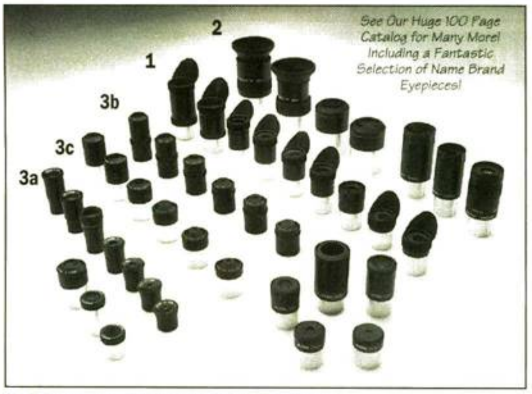

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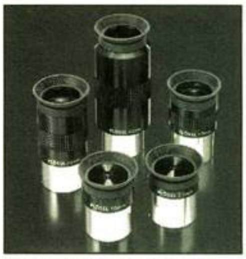

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Features double crossline reticle and red LED illuminator. Plugs into power panel drive bases.
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Shorty™ Barlows

The short bodies allow extra versatility: provides 2x magnification when the eyepiece is inserted directly and 3x magnification when positioned before the diagonal on a refractor or SC. These will work in all telescopes, including those where longer barlows won't work.

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The finest available, SkyGlow™ filters from Orion make detailed deep-sky observing possible from light-polluted city and suburban locations. Sophisticated multi-layer technology actually absorbs light pollution! Greater blocking and higher transmission than competitive models. See catalog for details.

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For slightly to moderately light-polluted areas.

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10" Model	12"x14"x62"	*#15137*	***$50.95*** (2.43)
12.5" Model	14"x16"x68"	*#15138*	***$59.95*** (2.43)

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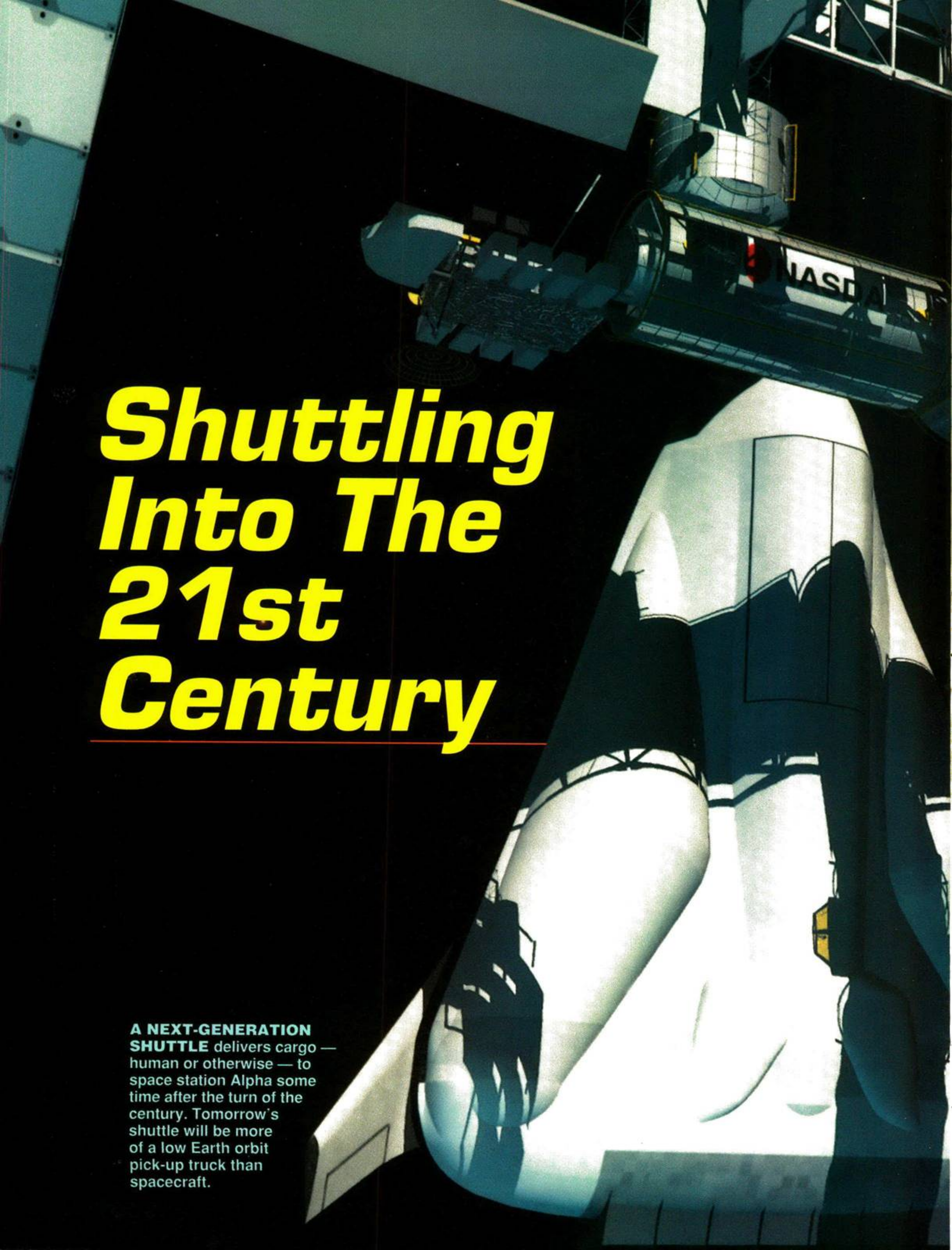
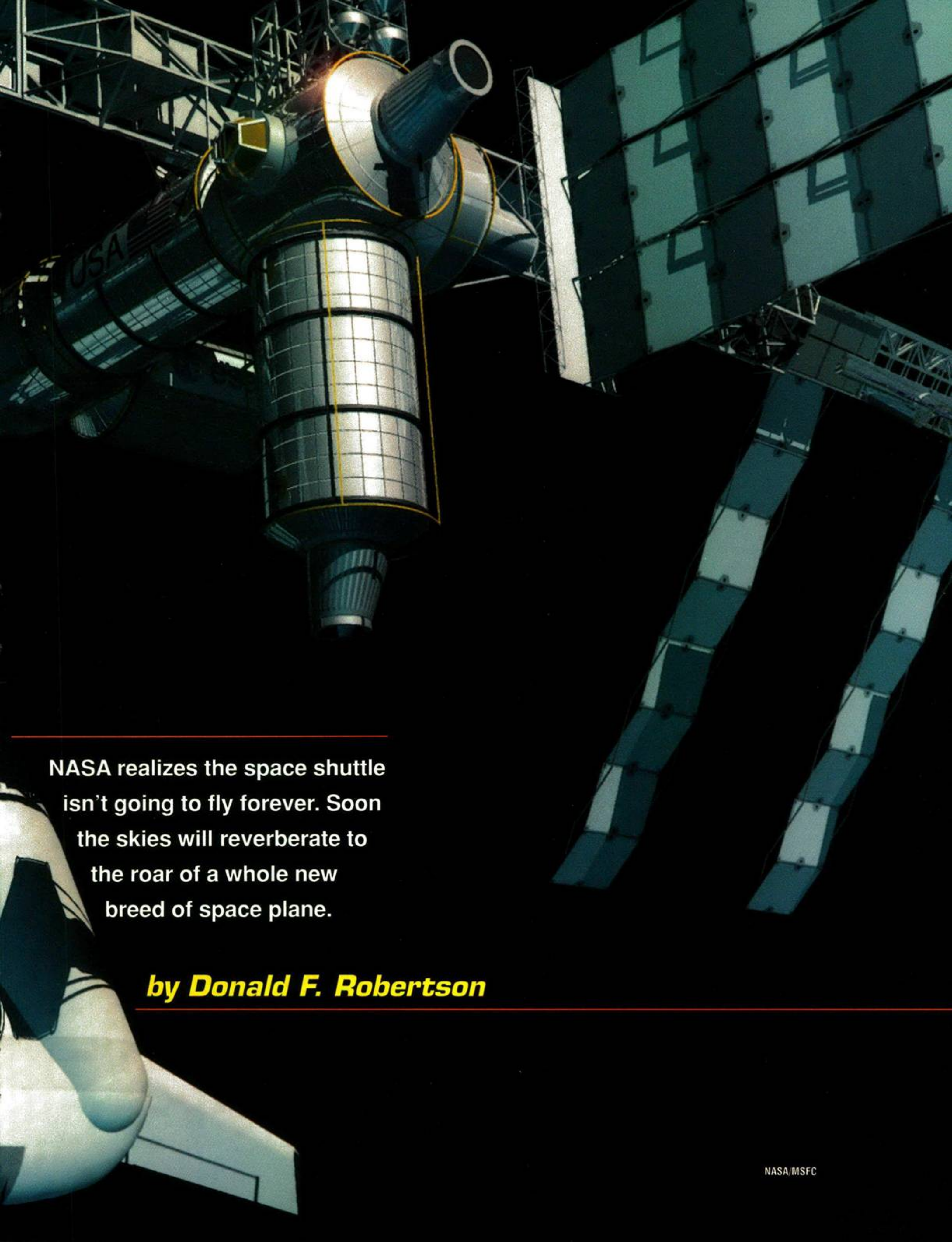


Shuttling Into The 21st Century

A NEXT-GENERATION SHUTTLE delivers cargo — human or otherwise — to space station Alpha some time after the turn of the century. Tomorrow's shuttle will be more of a low Earth orbit pick-up truck than spacecraft.



NASA realizes the space shuttle isn't going to fly forever. Soon the skies will reverberate to the roar of a whole new breed of space plane.

by Donald F. Robertson

NASA/MSFC

The space shuttle is growing old. In theory, it is capable of flying on for at least another 25 years. But those flights cost a lot of money, and if another Challenger-type accident happens, the fleet will be grounded — this time forever. On top of that, today's shuttles have done little to reduce the high cost of reaching orbit. Flying the shuttle costs NASA something between $3 and $5 billion every year, depending what is billed to the program. These costs are hard to reduce without drastic revisions in the way NASA does spaceflight.

For years, advocates of commercial space flight have claimed that if the government would get out of the way, private industry would explode into the manned and unmanned launcher business. Now NASA Administrator Daniel Goldin is about to give the aerospace industry a chance to live up to its rhetoric. Give America cheaper access to space, he says. "Shuttle America into the next century" is his mantra.

Lose the Training Wheels, Boys

As an experimental craft, the space shuttle broke technological frontiers, becoming the first regularly reusable launch vehicle. As operational "spaceliners," they have made human spaceflight a relatively routine activity. Almost every flight demonstrates a new capability in space. So why not simply build a new and better space shuttle? The problem, of course, is money.

With so much of it tied up in today's manned operations, there is little cash to develop a new, second-generation shuttle that might be cheaper to run. Why continue flying today's shuttle if that money can better be used to develop a new vehicle?

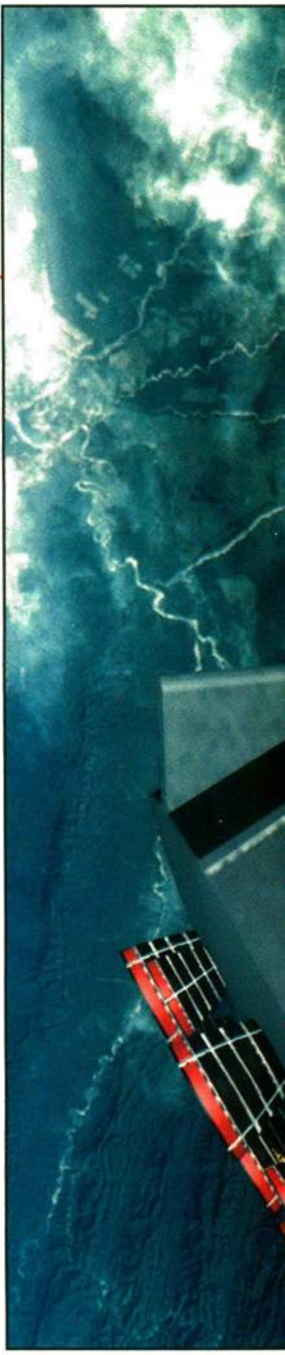
Politically, gutting the shuttle completely is extremely risky. Unless an aerospace company takes over the existing space program, it means abandoning human spaceflight for the years it will take to ready a new vehicle. That, in turn, would jeopardize the Space Station, viewed by some planners as essential if humans are ever to push into the solar system. Simply put, all forward momentum in human spaceflight, both technical and political, would be lost if the shuttle were axed.

NASA's been grappling with this catch-22 ever since it became clear the shuttle would not live up to the agency's hopes for cheap access to space. To find its way clear of this quandary, NASA is forming a partnership with industry.

Enter the X Decade

NASA wants to split the cost with industry for developing two new experimental reusable launch vehicles. One, the X-34, is a tiny, fully or nearly reusable rocket designed to lift 1,000- to 2,000-pound payloads (the weight of many communication satellites) into low Earth orbit. The second program, the X-33, would be larger and carry more payload, including humans, into higher orbits. NASA stipulates that both must use a single set of rockets to lift their cargo into space, a concept called "single stage to orbit" or SSTO.

Goldin has found a few hundred million dollars in NASA's budget to fund X-34 and X-33. It will pay for approximately half of the $140 million X-34. NASA's share of the X-33 program is estimated as $18 million for initial studies, followed by $650 million to build the test vehicle. Aerospace companies, if they want to develop a second-generation shuttle with NASA's help, must match these amounts "at a minimum," says Goldin.



A QUICK DIP INTO SPACE is all that's needed to send two satellites into orbit. After its brief mission, this shuttle lands vertically on a pad, is reloaded with fuel and payload and then shot into space again.

The smaller X-34 is a relatively straightforward project. NASA puts up $70 million and the winning company matches it. Four years and $140 million later, the United States will have a modern, reusable, small launch vehicle, a rocket for which there is an unquestioned market. Much of X-34's technology can come from Pegasus, a disposable winged booster that has flown for many years.

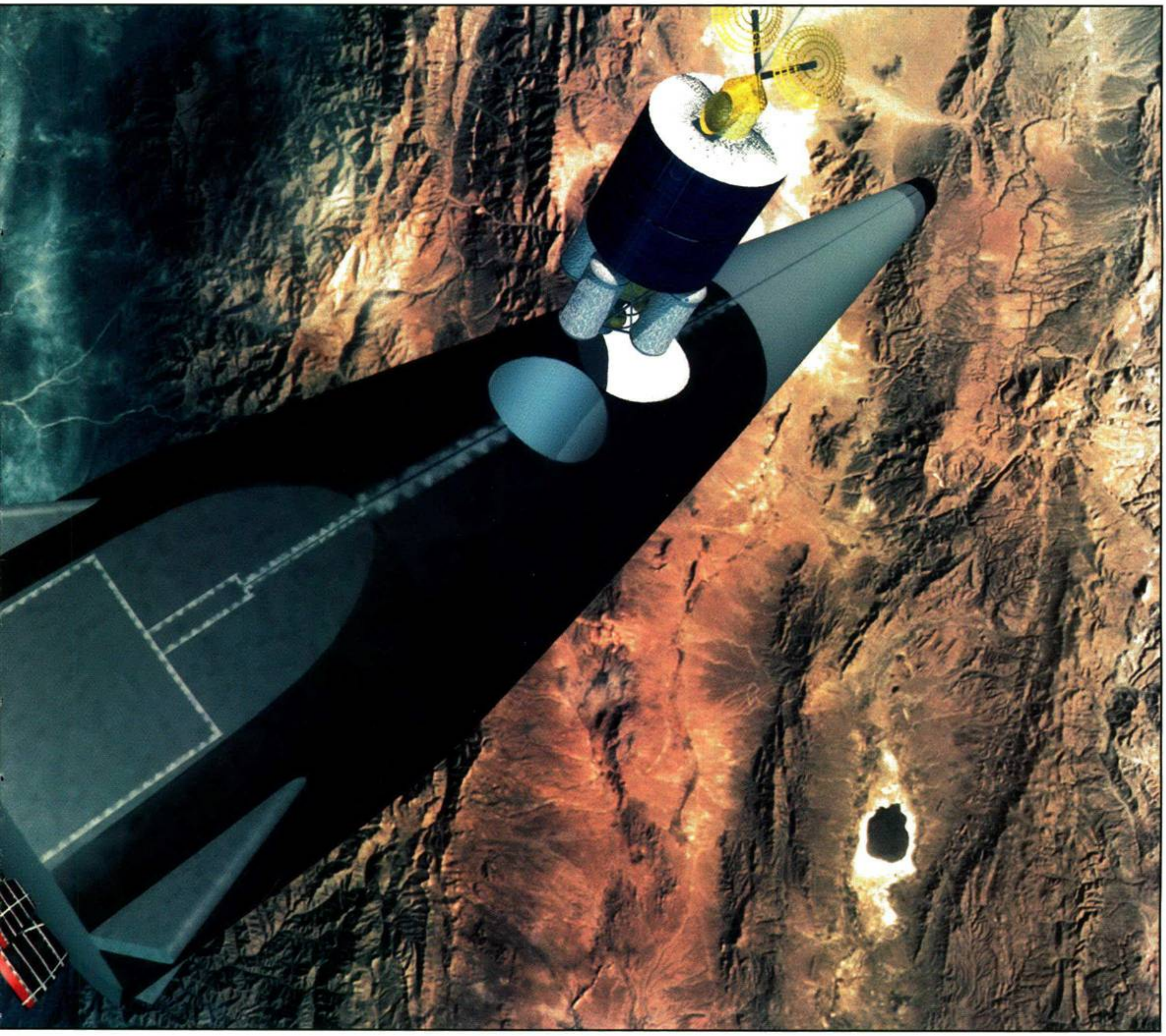
But the bigger X-33 is a bit more complex. For a start, it is a test vehicle from the word go, with no guarantee of success. It will be hard to make money without any certainty that the government will buy flights on an operational vehicle. Any operational shuttle culled from the X-33 program is certain to cost a whole lot more than $650 million. The space agency has said up front it's defraying X-33 development and testing only. Anything beyond that, be it an operational manned or unmanned shuttle, comes from the private sector's pocket.

What will the X-33 look like? It's still too early to say, for the program is just getting started. However, some characteristics of the new shuttle are not open to negotiation. They are dictated by the twin constraints of physics and a fast development schedule.

A Russian Connection?

The X-33 will almost certainly use a variant of the current rocket engine, according to speculation in aerospace circles. NASA's Goldin is in too big a hurry to wait a decade for the development of a new engine. One alternative being considered is something called a "tri-propellant" engine developed by the Russians. The engine burns kerosene close to the ground and then switches to hydrogen at high altitudes, burning each fuel with the same supply of liquid oxygen — hence the name "tri-propellant."

Such an engine has tangible benefits. Kerosene is



NASA/MSFC

heavier than hydrogen, which means X-33 carries a greater mass of kerosene in a given tank. It burns at a relatively low temperature, so engine exhaust leaves the rocket nozzle at a slow speed, but its greater weight means that it provides lots of propulsion to the rocket. This is important early in X-33's flight, when the vehicle is still laden with unburned fuel.

Hydrogen is lighter and requires larger, therefore heavier, tanks. But it burns much hotter, leaving the rocket at high speed. This provides much greater efficiency but less push. Burning hydrogen is most useful high above the atmosphere, after much of the fuel has been burnt and the vehicle is relatively light.

A tri-propellant engine has many advantages. Design differences between a kerosene-burning engine and a hydrogen-burning engine are not all that great. X-33 burns the type of fuel that is best for each altitude and needs just one kind of engine, saving the weight of separate engines for low- and high-altitude flight. Besides, in desperate need of hard currency, the Russians are eager to sell their technology. The rub is that the Russians have not actually used this rocket.

Because of this, chances are good that NASA will stick with improved shuttle engines or an updated version of the RL-10, the world's first high-energy rocket engine still used on the Centaur, an existing disposable booster. This is not just because these rockets were designed and made in America.

SSTO advocates in Congress believe that tri-propellant engines are needlessly complex and that sticking to one fuel is more than worth the larger vehicle required. After all, the principal reason for the shuttle's high cost is not its (cheap) fuel or its inefficiency, but its extreme complexity. The shuttle needs a "standing army" of engineers to tinker it into operation. Hence the cry of SSTO proponents: Above all, keep it simple.

The Shape of Things To Come

As for the shape of X-33, it depends on which aerospace design team you talk to. A winged craft that takes off horizontally benefits from simple fuel tanks and well-understood aerodynamics. Its main disadvantages are the extra weight of wings, its inability to handle large payloads, and the need for high landing speeds on a long and costly runway.

Another concept foregoes wings altogether, using a so-called "lifting body shape" that incorporates wings into the vehicle's design. It would be lighter, carry more payload, and have a lower landing speed, letting it land at shorter airfields. The challenge would be fitting it with the proposed engines and tanks, as well as coping with a complex airframe.

The last design, vertically launched and shaped like a cone, has one distinct advantage: It's been tested with rockets. McDonnell-Douglas flight-tested this concept during the 1980s as part of a Star Wars contract with the Pentagon. NASA has inherited the program, and this year an upgraded vehicle called the DC-XA will fly.

McDonnell-Douglas, with partner Boeing, might throw its hat into the X-33 ring with a DC-XA derivative. Two major hurtles confront this approach: The need to keep fuel for a soft-landing and the complexity of restarting rocket engines in Earth's atmosphere.

Regardless of who goes with what design, the X-33's development schedule calls for NASA to fund the first $18 million this year and split it among the aerospace companies for Phase I studies. In March NASA selected Lockheed-Marietta, McDonnell-Douglas, and Rockwell International to draw up proposals for financing the test vehicle and present plans for commercially funding an operational shuttle. By early summer 1996, the White House and Congress will use these studies to decide

Don't Write Off Space Shuttle Yet

NASA

Given that the country's budget problems are likely to continue far into the future, the alternative to a commercial shuttle appears to be grim: a future of continuing to launch a few commercial communications satellites and an occasional planetary probe on ancient, unreliable, and hugely expensive converted inter-continental ballistic missiles. There will be no true exploration of space by astronauts, no industries in space, and no human settlement of the planets.

The World's First Spaceship

But there is, in fact, a middle road. The space shuttle, by some measures, is a hugely capable spacecraft. The operative word is "spacecraft." The shuttle's many problems mostly involve the process of getting into and, to a lesser extent, out of orbit. While in space, its pilots view the orbiters as "exquisite" flying machines and extremely stable platforms capable of the most precise maneuvers. Unlike any previous spacecraft, these can be flown. On the ground, meanwhile, grousing taxpayers confront the system's cost.

But for the most part, shuttle costs are fixed. That is, the major expense is not in actually flying the shuttle, but in maintaining launch pads, control rooms, and a standing army of engineers and technicians to refurbish the orbiters. Fixed costs are extremely hard to cut, and NASA deserves credit for successfully cutting these costs by about one-fourth.

On the other hand, costs for fuel and refurbishment hardware, the "incremental" costs, are relatively low. For each shuttle flight, the additional incremental cost on top of the fixed cost is large, but nowhere near the almost $1 billion-per-flight estimates of those who divide the total annual cost by the current number of flights each year (the annual cost of the shuttle program, $3 billion to $5 billion, divided by five to eight flights).

The incremental cost of one shuttle flight is hard to pin down, but is probably somewhere in the neighborhood of $300 million. This is not much higher than the cost of flying the same payload on old expendable rockets.

Keep 'Em Flying More Often?

So one alternative is to continue flying the shuttles, do so more often, and have each mission stay in space longer. Unfortunately this is politically unpalatable. Sticking with the current shuttle maintains a high cost item indefinitely on the Federal books. Keeping the program flying also limits what we can do in space to what the shuttle can do. It does not allow any grand new projects for politicians and NASA engineers to sign their names to.

It is, however, the most pragmatic option. Investing more money in the shuttle system would enable a proven rocket to fly. The whether to go ahead with the test vehicle. Depending on the proposals, one or more companies will advance to phase II.

A positive decision (a big assumption, given that the national budget deficit is unlikely to be significantly smaller) means a phase II X-33 test vehicle will complete its tests before the end of the decade, "demonstrating the technology to build reusable launch vehicles with aircraftlike operations," according to NASA.

The phase II test craft will be a smaller, suborbital version of a fully reusable single-stage-to-orbit shuttle. NASA will use it to discover and solve the problems needed to build the real thing. In many ways, rocket energy equates to money. Less energy costs less money. It takes much less energy to lob something into a suborbital trajectory than it does to attain orbit, even if both are at the same altitude. Suborbital flights are enough to gauge the stress and strains any new orbital shuttle would experience during its journey to and from space.

As NASA puts it in its agreement with industry: "The X-33 will demonstrate the critical technologies needed for orbital SSTO rockets in realistic operational environments. To the extent practical, the X-33 will be tested in the ascent and re-entry flight environments of a full-scale rocket," while also demonstrating the flight techniques and low-weight materials needed for a real SSTO.

At the end of the tunnel is a fully reusable, second-generation space shuttle. That's phase III: "If fully successful, [these flight tests] will result in a low-risk, low-cost development of a commercially operated reusable launch vehicle system," says NASA.

Build It and They (May) Come

And that is where NASA stops. If there is to be a new operational shuttle, it has to be a commercial vehicle. There will be no more free lunch for the aerospace industry. If American companies want to compete in

---

shuttle has achieved about 70 successful flights with only one failure, making it the second most reliable large rocket ever developed. It's second only to the much smaller Delta, an expendable rocket that has flown for 30-plus years. The shuttle carries to orbit a huge payload and with modification can carry a much larger one. And shuttle crews have proven their worth time and again, most recently with the repair of the Hubble Space Telescope.

Building Better Turbopumps

To some degree, this strategy is what the United States has chosen by default. Unable to make a decision and with no alternative in sight, the country simply continues to fly and to improve the shuttles.

In addition to introducing new and safer main-engine turbopumps, engineers are increasing the nozzle throat diameter to let the engines run at lower pressure with less mechanical stress. Another group is changing the interior control panels from electromechanical equipment that needs a lot of maintenance to a "glass cockpit" with touch-sensitive computer screens that are less prone to breakdown and provide a lot more control for less weight and money. Other plans to redesign the solid rocket boosters and switch to lighter fiber optic wiring have been canceled or put on hold indefinitely.

Sure, the shuttle costs a lot of money, but we're getting a lot for our money, too. People forget what things were like before the shuttle. Human orbital missions occurred two or three times a year and accomplished almost nothing beyond the flight itself, and by any measure the total cost was far higher.

Are the orbiters up to the job? Apparently so. Over the past few years, NASA has refurbished and upgraded the shuttles. In the process, the orbiters underwent detailed structural examinations. NASA representatives claim that the orbiters are in great shape and probably can fly as far into the future as necessary, publicly owned or otherwise.

Several Billion Buys Them All

Is there a way to take the shuttles out of the government budget while keeping them flying so that NASA can concentrate on helping industry develop a replacement? Maybe so.

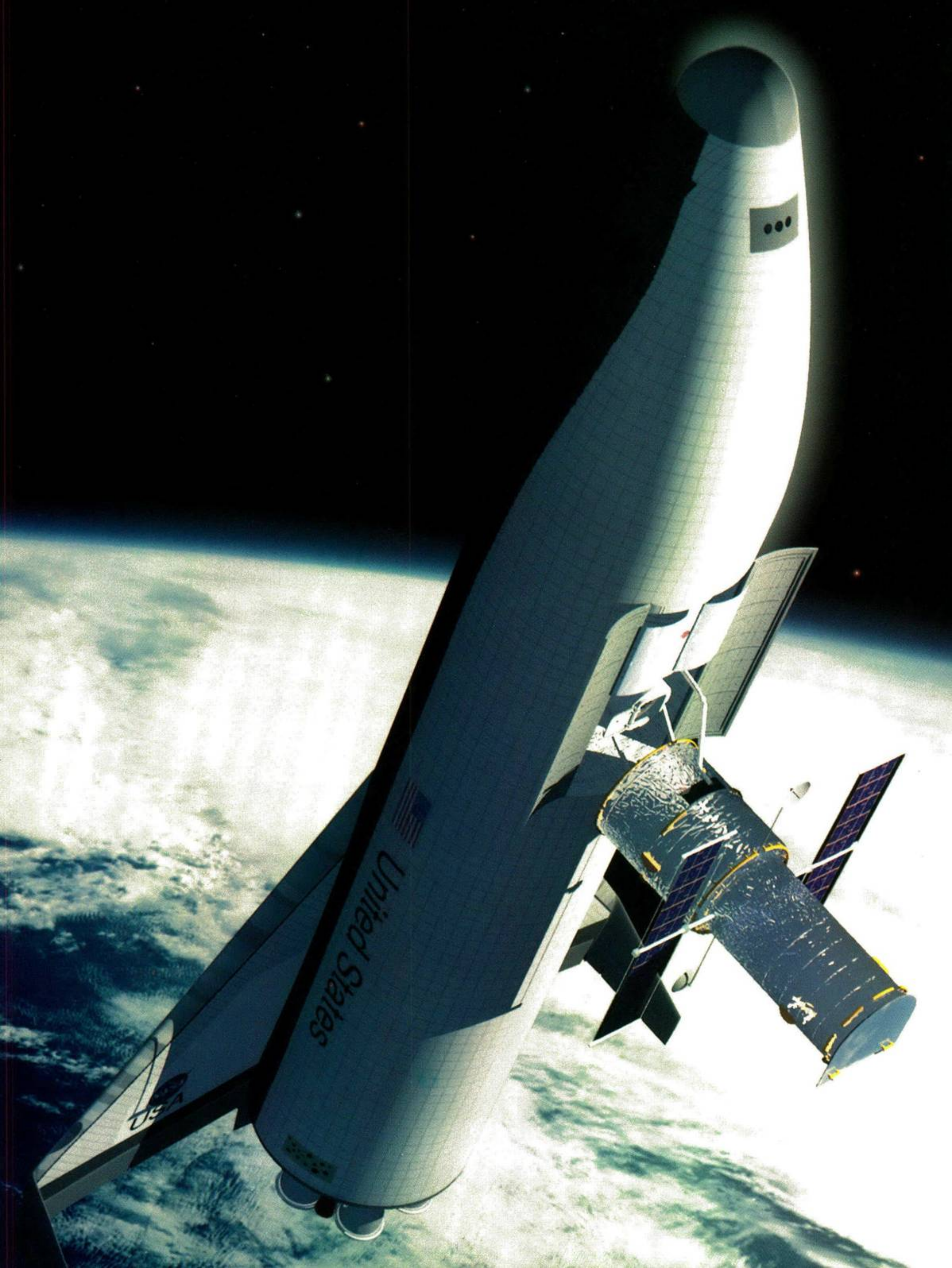
There is revived talk both in NASA and in Congress of commercializing the shuttle system. This would consist of setting up a government chartered corporation, like Amtrak or Europe's Arianespace, which launches Ariane rockets. In a government-chartered company, the government puts up the money but the organization otherwise behaves much like a private company. The idea has a long and successful career in the history of exploration — the British East India Company that did much to create Britain's commercial empire was a government-chartered company.

The idea has one key advantage that many of the other dreams of space advocates don't: It is known to work. It allows semi-private projects that are uneconomical for the private sector to undertake by themselves.

Rockwell once offered to take over shuttle operations, as did several other companies. Probably much to their subsequent relief — this was before the Challenger disaster — NASA declined. NASA believed Rockwell could not successfully make a commercial operation out of the shuttle; cynics believe NASA simply did not want to lose control of the program.

Today, however, the shuttle is in successful, regular operation, and if the government were willing to pay what launches actually cost, it could probably be commercialized. A commercial space shuttle could remove a big item from NASA's budget. NASA would pay for each launch and, along with other customers, shoulder the fixed expense of shuttle spaceflight.

Republicans in Congress, who like the idea of commercializing government services, might support the idea. It would free up money to do what NASA was originally founded to do: develop new technology. Perhaps a new technology for that single-stage-to-orbit shuttle . . . and then, a lunar or planetary base?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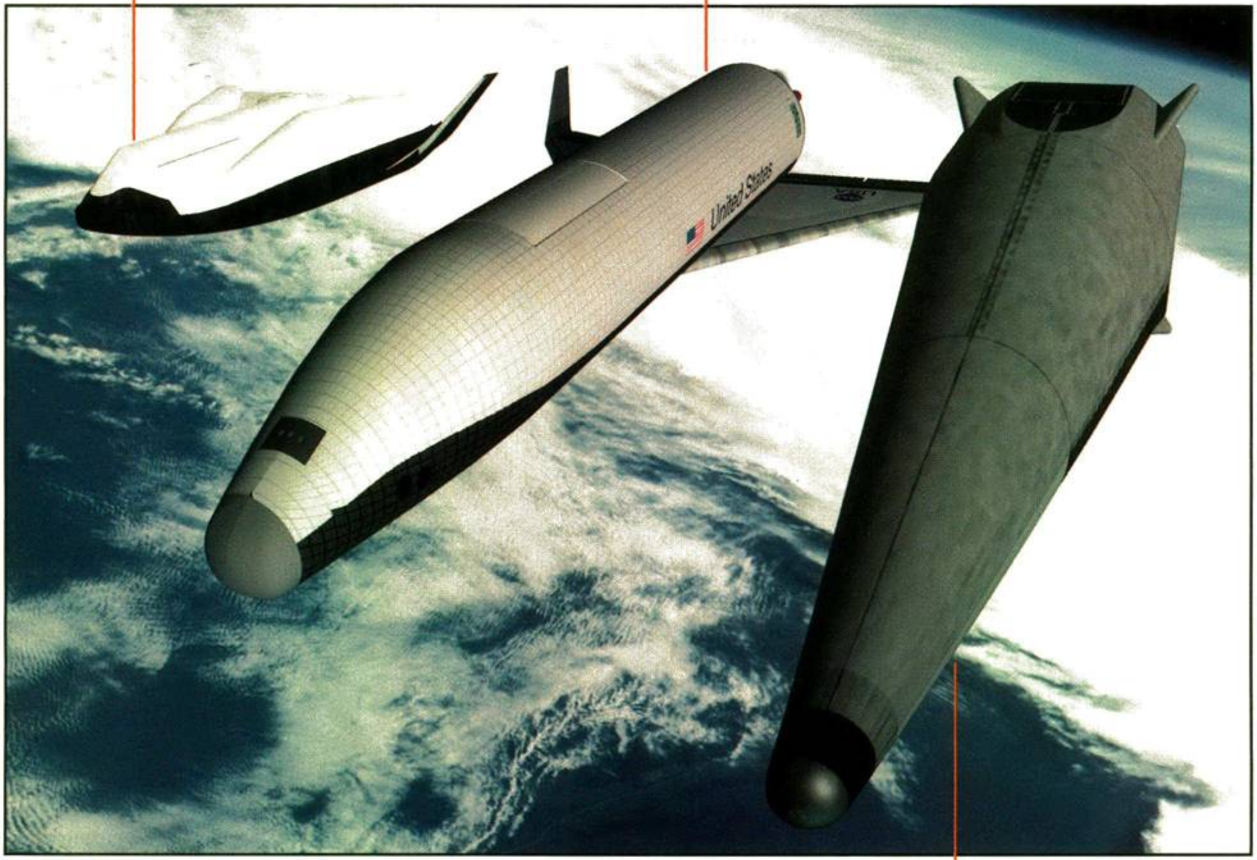
LIFTING BODY

Pros: Low reentry temperatures
Low landing speed
Lightweight design
Cons: Complicated airframe
Engines difficult to design around

WING BODY

Pros: Simple fuel tanks
Well-studied aerodynamics
Easy maneuverability after reentry
Cons: Limited space for payload
High landing speed



NASA/MSFC

CONICAL

Pros: Lightweight airframe
No weighty wings
Simple aerodynamic shape
Cons: Rocket engines that need restarting after reentry
Requires lots of fuel
Limited space for payload

delivering satellites and material to orbit in a market place now dominated by the Europeans and increasingly by the Russians and Chinese, then the aerospace companies will have to cough up most of the money.

After the X rockets first fly, it might require five billion dollars to develop a fully operational shuttle system — a lot of money, even for giant aerospace conglomerates. With X-33, companies are being asked to bet on a high-risk project without the benefit of a large money-wielding government agency waiting to guarantee a return on investment. Maybe, NASA wagers, the aerospace industry will search its collective soul and find a way to do things a bit faster, smaller, cheaper, and better. Does that approach sound familiar? These are buzzwords used in Washington for "reinventing government."

And now the billion-dollar question: Will industry really come to the table with its purse?

Bill Gaubatz, X-33 program manager for the McDonnell Douglas/Boeing team, seems to think so. "We are in this for the long haul. Corporate money, Wall Street money, investment money — whatever you want to call it — is out there, if you can demonstrate that you have a technology and a market," says Gaubatz. "Investments have to be driven by economics that bring in a fair return to our stockholders. The government needs to do the risk reduction and NASA has to be a predictable customer."

And NASA probably can be such a customer. "It's predictable today," says Gaubatz. "The government spends $7 billion per year on space transportation."

With that bird in the hand, capitalist Gaubatz and his aerospace colleagues have their sights set on low Earth orbit. In their boardroom visions, a new century brings the promise of a profitable, economical spacecraft that is in every sense of the term a space shuttle. ☐

NASA/MSFC

IN ITS MANNED INCARNATION, a next-generation shuttle services the Hubble Space Telescope. This so-called "wing-body" design takes off vertically and lands on a runway.

Donald F. Robertson is a science writer based in the San Francisco area. His last ASTRONOMY *article was "To Boldly Go" in December 1994.*

Bruce Bond

Dog Days and Twinkling Stars

Sirius, the Dog Star, signals sweltering weather that causes stars to twinkle.

by Jeff Kanipe

It's hot. Summer has its hold upon us and we are in full sweat. The middle of the day is warm and still; the afternoon, suffocating. No breeze, no benevolent clouds. The forecast for tonight calls for much the same. Grass is brown, and the ground is hard. Cicadas whine in the trees, and dogs sleep heavily on cool concrete porches. If we're lucky enough to be relaxing at home, we're ensconced in a hammock or lawn chair, nursing a sweating glass of iced tea and staring out at the waves of heat that infuses the day with a kind of waking dream quality. The whole world seems held in stasis.

These are the notorious dog days of summer, a time when the bright star Sirius, in the constellation Canis Major, rises with the Sun. The shimmering heat of the day usually translates to twinkling stars at night and boiling images in a telescope. But not always. With the right conditions, dog-day observing can be great.

Summer is hot because the Sun beats down from nearly overhead and for a longer time each day compared to winter. Without the atmosphere and oceans, the warmest days in the Northern Hemisphere would occur around June 21, at the summer solstice, when the noontime Sun appears highest in the sky and the day is longest. But the hottest days usually lag the solstice by about a month because land and the vast oceans are slow to warm up.

During the dog days, more heat is being put in than taken out: Earth's surface cannot radiate solar heat away into space fast enough to keep the surface cool.

Instead heat accumulates, even though the Sun is already heading south. Not until the heating rate falls below the cooling rate does the temperature begin to fall, and we sense the coming of autumn.

In ancient times, people in places like Egypt and Greece associated the dog days with Sirius in Canis Major, the Greater Dog. Sirius is called the Dog Star partly because it is the brightest star in the Greater Dog but also because it acts as a sentinel. The star's timely appearance in the east in August gave ancient Egyptians enough warning to prepare for the annual inundation of their fields by the Nile. Hence, the Egyptians likened Sirius' appearance to that of a barking dog warning its master of peril.

But perhaps more important, Sirius's arrival in the eastern morning sky was a sign that the land would become fertile again from the rich sediments deposited by the floodwaters. The Egyptians so revered Sirius that they built a temple in its honor, Isis Sothis at Denderah, and depicted the star as a god with a dog's head. They called the god Anubis.

Today in the Northern Hemisphere, this star is primarily known for its appearance in the winter sky. In fact, most folks notice it highest in the south on mid-February evenings when the cold north winds still prevail.

Barring a total solar eclipse, however, we can't see Sirius in early July. It lies too near the Sun, lost in its glare. The star rises with the Sun around July 31 and then precedes it thereafter. Begin looking for Sirius in early August, between the 5th and the 10th. You'll need a clear, uncluttered eastern horizon, and binoculars help. To narrow the search area, let Orion the Hunter guide you: It rises about an hour or so earlier, and a line drawn downward through his belt stars points to Sirius. By early September, you'll have no trouble seeing Sirius beaming in the twilight above the southeastern horizon around 5:30 a.m.

When Sirius is just rising, you see it through a lot of atmosphere the bends the star's light like a prism. The hot, unsettled atmosphere thus makes the star twinkle furiously as a brilliant multicolored luminary. This violent twinkling gave the star its name and tied it to the dog days of summer. Sirius comes from the Greek *seir*, meaning "to shine," but scholars often translate it to mean "sparkling" or "scorching."

As the ancient Egyptians learned to watch for Sirius as the sentinel of Nile flooding, they came to associate the star's morning apparition with summer's heat. These skywatchers knew that the stars rise a little earlier each day. Judging by Sirius's appearance just before sunrise in August and its subsequent ascension in the eastern sky each morning, the old astronomers noted that the star must have risen with the Sun during July, in other words heliacally.

As today, July marked the onset of the sultry weather of summer. Hence the Egyptians came to associate the unusually hot days with this star. Some

Greeks speculated that Sirius's brilliant light rays combined with those of the Sun, thus compounding the heat and creating the associated torpor of summer. The Romans called the 40-day period from July 3 to August 11 the dog days.

Martha Evans Martin, in her classic book *The Friendly Stars*, puts it more eloquently:

> *The constellation [Canis Major] gives the name of "dog days" to the hot and trying period of the summer, including most of July and the first half of August. During this time Sirius rises just after the Sun, and following it over the heavens each day, the star was supposed by the ancients to be in some way responsible for the malign heat of the midsummer Sun and to exert an evil influence on the health of those exposed to its burning rays. Even now, we frequently hear that dogs are likely to go mad at this season because the Dog Star is in the ascendant.*

Of course, Sirius doesn't really contribute to the summer heat. It's just a bright star that flickers like a windblown candle flame, especially when seen near the horizon. This mad sparkling makes it look as if it has burning rays. Sirius has a temperature of over 9500 kelvins and undoubtedly emits such rays, but from a distance of over 8 light-years, they don't faze Earth in the slightest. That's not to say that twinkling, which is more properly called scintillation, does not affect astronomers. It does and in a very unfortunate way.

When starlight passes through Earth's atmosphere, the different layers of air act like lenses that bend the rays. Enough bending occurs that, to the naked eye, the star's position appears to shift very slightly. When the air is unsettled, the amount of bending changes, which causes the star to appear to jump around.

Depending on how unsettled the atmosphere is, a bright star like Sirius can violently flash in different colors — blue, green, and red — and even appear to fluctuate slightly in brightness on the order of 0.05 second, or to put it in a less quantified way, the wink of an eye. A first-magnitude or brighter star can appear to jiggle around in position at an equally rapid rate. Arcturus in Bootes also does this, as does Capella in Auriga. People unfamiliar with the night sky may perceive a just-rising bright star as a much closer object moving in the sky (that is, a UFO).

Planets usually don't twinkle. Even when Venus or Mars do appear to twinkle, they do so much less than the stars. That's because, unlike stars, planets are extended sources whose light is spread over an area of sky. Light comes from every part of that region, not just a single point. Even if one ray of light jumps as it passes through the atmosphere, the other rays don't, so the apparent shift in the planet's position is less than the apparent size of its disk in the sky.

Another way to look at this is to imagine standing on a diving board over a cool, clear pool of water

(which, during the dog days, is a preferred location). A bright coin on the floor of the pool appears to flick about because the water acts like a wavy lens that continuously distorts the rays of light from the coin. On the other hand, someone floating underwater looks fairly steady because the water cannot distort the light rays coming from the body's greater area enough to shift body parts wildly out of position.

Scintillation has always been a problem in astronomy. Both astronomers and romantics sigh at a sky full of twinkling stars, but not for the same reasons. The romantic says, "Ah! Beautiful!" and writes a sonnet. The astronomer says, "Ack! Bad seeing!" and builds a space telescope.

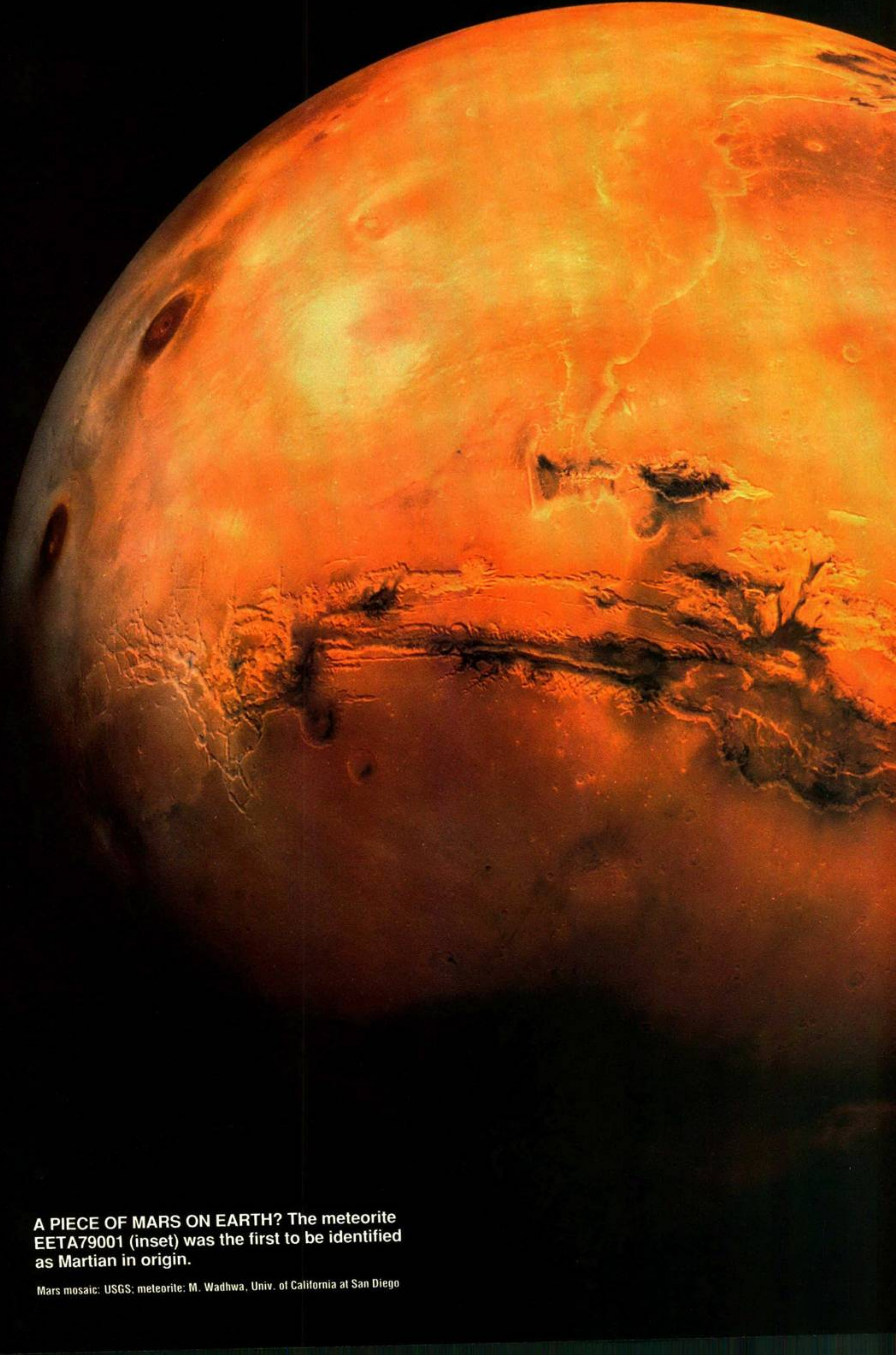
Twinkling indicates turbulence in the atmosphere that arises from the chaotic mixing of air masses of different temperature. Turbulence means trouble, especially for planet and double-star observers needing to see fine detail. It gives Sirius its scintillating beauty upon rising, but also produces poor seeing conditions near the horizon. As a general rule, the seeing gets better the higher you look in the sky, because your line of sight cuts through less atmosphere.

But on some nights the seeing seems just awful all over the sky. These nights often occur in winter when the sky looks as transparent as glass. You would think this would be a good time to observe — and it is, for large extended objects like galaxies. But Mars? Forget it! The turbulence caused by the mixing of cold and warm air masses makes the stars sparkle and the seeing poor. Planet images boil, and close double stars merge into a muddle of shifting light.

When it comes to dealing with an unsettled atmosphere, smaller telescopes often have the advantage over big ones. Large apertures, although they resolve more detail, also look through more turbulent air cells. Close doubles and fine lunar and planetary features get lost in the agitated currents of air that a large telescope must look through, while smaller telescopes, looking through a much smaller air parcel, render steadier images and, hence, more detail. But the seeing in any size telescope will be better on nights when the stars don't twinkle very much, even if the sky is not crystal clear.

Which brings us back to those hazy, crazy dog days of summer. To be sure, it may be insufferably hot during the day, but the seeing at night can be quite good, especially when a high-pressure system settles into the region and sets up what meteorologists call an inversion layer. Then the air overhead gets hazy and stagnant, and people drive to work gasping in the ozone. The nights are still and full of bugs, and the stars shine dully in a glaucous sky. The poet says, "Ack!" and goes to bed, but the wise observer says, "Aha!" — and gets out his telescope. ☐

Jeff Kanipe, former editor of Star Date, *is now the managing editor of* ASTRONOMY.



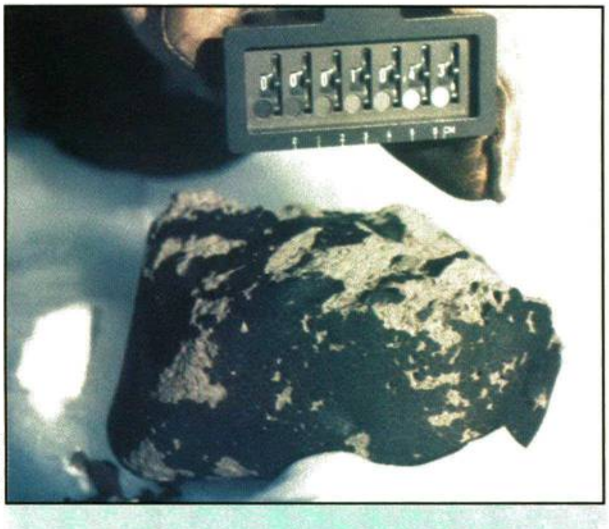
A PIECE OF MARS ON EARTH? The meteorite EETA79001 (inset) was the first to be identified as Martian in origin.

Mars mosaic: USGS; meteorite: M. Wadhwa, Univ. of California at San Diego

by Mark Robinson and
Meenakshi Wadhwa

Messengers from Mars

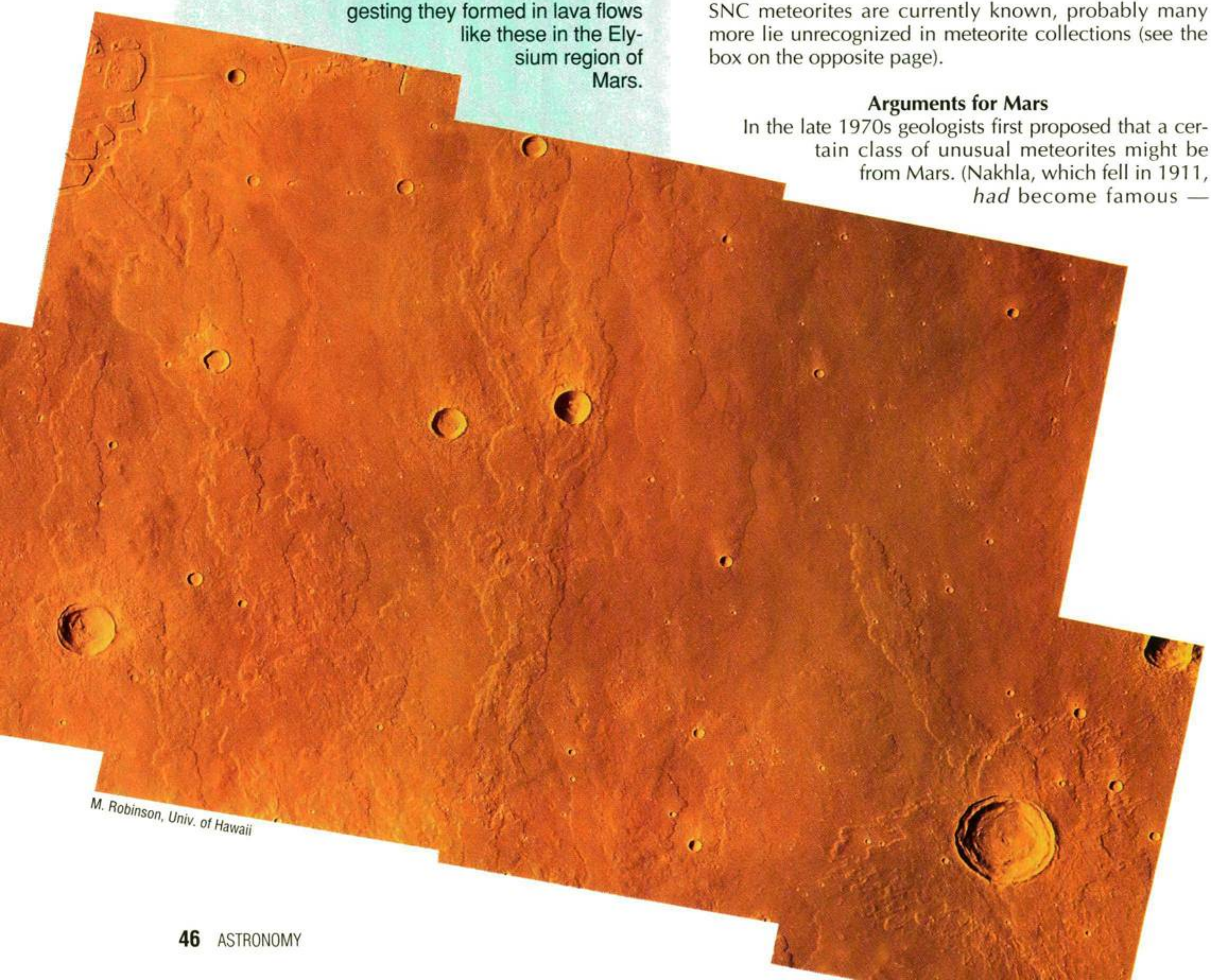
Meteorites recovered on Earth are passing on secrets of the Red Planet's past.



NASA/JSC

A VISITOR FROM ANOTHER PLANET, Mars meteorite EETA79001 sits on the antarctic ice in 1979. Lab tests four years later showed it was Martian in origin.

HOME TURF FOR MARS METEORITES? Some Mars meteorites have a texture suggesting they formed in lava flows like these in the Elysium region of Mars.



M. Robinson, Univ. of Hawaii

Nearly 20 years ago the United States landed two unmanned Viking spacecraft on the surface of Mars. The landers sent back pictures of the surface and conducted simple tests on the Martian rocks and atmosphere. This first step in understanding a planetary neighbor gave a basic picture of Mars. But to really know a planet, scientists need to subject its rocks to extensive analysis in laboratories on Earth. Lunar samples returned by the Apollo astronauts have let scientists gain a wealth of information about the geologic history of the Moon. But Mars has remained stubbornly out of reach. Or has it?

Out of the thousands of meteorites that sit in terrestrial collections, eleven are imbued with a special pedigree. These meteorites are believed to be pieces of Mars, delivered to planet Earth by nature itself. Scientists think these rocks arrived here after a huge impact (or several impacts) blasted them off the Red Planet, perhaps no more than 15 million years ago. Drifting in orbits about the Sun, the meteorites eventually wandered into Earth's neighborhood and were captured by its gravity.

These objects are the SNC (pronounced "snick") meteorites; they have turned up all over the world. Three falls — at Shergotty, India; Nakhla, Egypt; and Chassigny, France — gave them the nickname they now bear, but other SNCs have been found in Nigeria, Brazil, the United States, and Antarctica. While eleven SNC meteorites are currently known, probably many more lie unrecognized in meteorite collections (see the box on the opposite page).

Arguments for Mars

In the late 1970s geologists first proposed that a certain class of unusual meteorites might be from Mars. (Nakhla, which fell in 1911, *had* become famous —

but for being a killer: Nakhla had fallen as a shower of stones with a combined weight of about 90 pounds; one stone hit and killed a dog.) By the late 1970s, however, some planetary researchers had begun to suggest this class of meteorites might have come from Mars. Yet it took several years of intensive study to build a strong case.

One indicator of a Martian origin is the fact that SNCs are very young relative to other meteorites. Most SNC meteorites are 1.3 billion years or younger, while meteorites that originated on asteroid-sized bodies are about 4.5 billion years old, roughly as old as the solar system. (Even more exciting, though controversial, is the extremely young date of 180 million years determined for four SNCs.)

These young dates argue that since SNCs were molten relatively recently (in solar system terms), they had to come from a body large enough to have retained heat for more than 3 billion years after the birth of the solar system. And Mars fits the bill. Corroborating this is the composition of the SNCs, which points to a complex history of melting. A rock-forming history like that is impossible for an asteroid-sized object and, again, could occur only on a large body like Mars or Earth.

But the strongest and most direct evidence linking SNCs to Mars came from the discovery of gas bubbles trapped within some SNCs. In 1983, Donald Bogard and Pratt Johnson, researchers at NASA's Johnson Space Center in Houston, discovered that the composition of these gases matched very closely the measurements of the Martian atmosphere made by the Viking landers. These trapped gas bubbles were actual samples of the Martian atmosphere implanted in portions of rock that melted during the impact that blew the meteorite from the surface of Mars. Thus the rocks carried direct samples of the Martian atmosphere to Earth. Without the data from the Viking landers, scientists would never have been able to determine where the SNCs came from.

The chemical and physical characteristics of the SNCs clearly pointed toward a Martian origin. Yet some scientists were initially leery of the conclusion because early models of impacts indicated that it was impossible for the SNCs to have come from Mars. With refined impact models and the analysis of the SNCs' chemistry, however, planetary scientists now almost universally accept a Martian origin.

Interestingly enough, the existence of SNCs had been foretold. As early as 1963, U.S. Geological Survey scientist Gene Shoemaker had predicted that scientists would find Mars meteorites on Earth. Shoemaker reasoned that big impacts would have occurred on Mars and that "at least some very small fraction of this [ejected] material would ultimately collide with the Earth."

What Can We Learn from SNCs?

Previous studies of Martian volcanos and lava flows using Mariner and Viking images had led scientists to infer that Martian lavas were similar to certain terrestrial rocks (mostly basalts and other iron-rich rocks). The SNC samples provided a "ground-truth" check on the idea and have given a wealth of detail on the geological history of the Red Planet. These fascinating planetary interlopers have also pointed out similarities between terrestrial and Martian rocks.

Unlike rocks from the Moon and asteroids, SNCs

The New Old SNC

The SNC meteorite designated ALH84001 was the tenth such object identified as a meteorite from Mars. Scientists collected the rock from the Allan Hills region of Antarctica in 1984, believing it to be an asteroidal meteorite. Only recently did David Mittlefehldt, a scientist at NASA's Johnson Space Center in Houston, discover the object's Martian origin. This newly identified SNC stands out from the other known SNCs in that it is much older than their 1.3 billion years: ALH84001 probably formed early in Mars' geologic history, perhaps around 4.5 billion years ago.

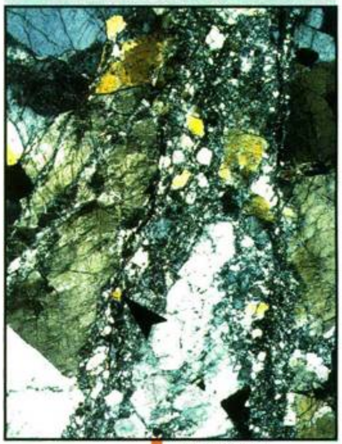
Also in contrast to the rest of the SNCs, which likely formed in the young volcanic terrains of the northern hemisphere of Mars, this "new" SNC most probably formed in the older highland terrains of the planet's southern hemisphere. Another difference is that ALH84001 contains the greatest amount of carbonate minerals of any SNC. The presence of these minerals in such abundance indicates that carbon dioxide- and water-rich fluids once actively circulated through crustal rocks on Mars.

The differences in age and area of origin for the new SNC meteorite carry an important implication. Both suggest that SNC meteorites came from at least two distinct major impacts that threw Martian rocks into space. And if this idea holds true, then rocks may have been blown off the surface of Mars and traveled to Earth more commonly than planetary scientists have previously thought. This in turn suggests that perhaps many more Martian meteorites lie uncollected — or unrecognized — on Earth. After all, the new SNC wasn't recognized as such for about ten years.

In March 1995, Keizo Yanai of Japan's National Institute of Polar Research and Robert Clayton of the University of Chicago announced the discovery of the eleventh known SNC. This newest SNC was housed in the Japanese antarctic meteorite collection, where it had originally been identified as a diogenite, a type of asteroidal meteorite. Little is known of this new find, although preliminary geochemical analysis confirms its association with previous SNCs.

How many more SNCs sit in existing meteorite collections awaiting identification?

"NEW OLD" SNC
ALH84001 shows white and yellow crystals of pyroxene in a thin section seen with polarized light. Gold-colored grains are carbonate minerals, that suggest water percolated through the Martian crust ages ago.



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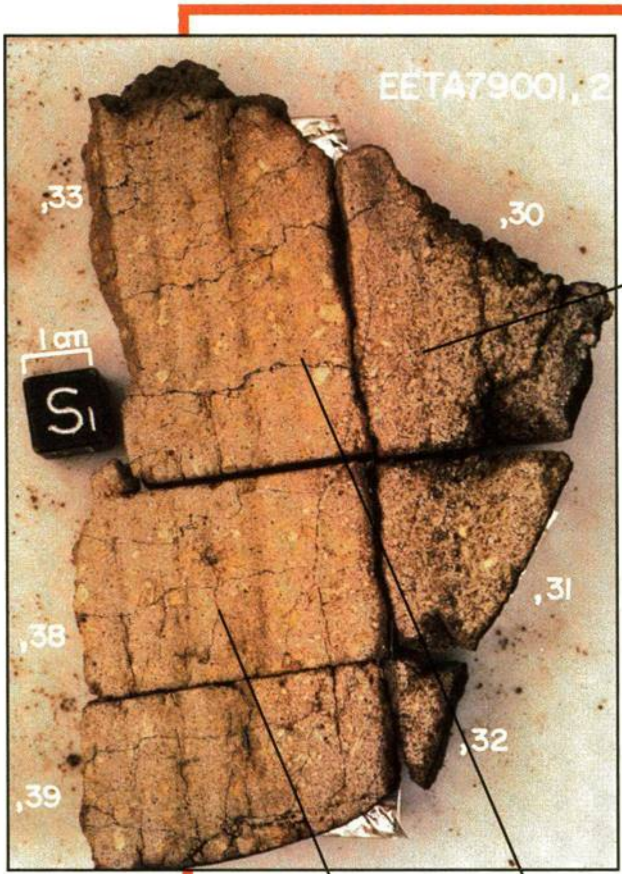
at San Diego

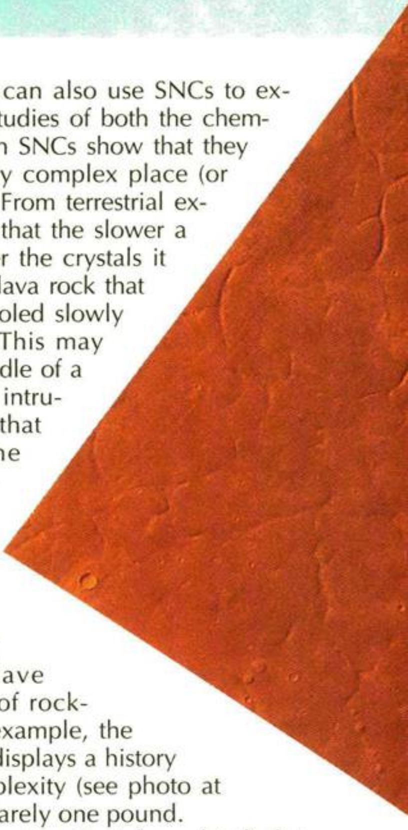

EETA79001,2
,33
,30
,31
,38
,32
,39
1 cm
S1
Coarse-grain lava
Fine-grain lava with large pieces of local rock
Shocked glass (dark veins) formed in the impact that blasted the rock off Mars.

M. Wadhwa, Univ. of California at San Diego

NO OTHER METEORITE KNOWN displays the complexity of EETA79001. Its two separate rock types show that it probably formed in two eruptions from the same volcanic vent on Mars.

contain minerals that hold water locked in their crystalline structure. Moreover, the compositions of oxide minerals in some SNCs indicate that the level of oxygen in the magmas out of which they formed was similar to the oxygen levels in Earth magmas.

SNCs also show that at some point in the past Martian rocks underwent surface weathering similar to that experienced by rocks on Earth. For instance, some SNCs contain carbonate minerals that formed by the breakdown of calcium-rich minerals in a carbon-dioxide-rich and a water-rich fluid. These carbonate minerals confirm the existence of groundwater on Mars, which planetary scientists had suspected since they began studying orbital images of valleys apparently carved by water.



SPLAT! The blanket of debris around the Martian crater Arandas (right) has the shape that results when an impactor strikes ground either soaked with water or full of ice. Some SNC meteorites contain minerals suggesting groundwater on Mars.

Planetary researchers can also use SNCs to explore Martian geology. Studies of both the chemistry and mineral forms in SNCs show that they came from a geologically complex place (or several places) on Mars. From terrestrial examples, geologists know that the slower a lava bed cools, the larger the crystals it will grow. The sheets of lava rock that produced some SNCs cooled slowly with little disturbance. This may have occurred in the middle of a thick lava flow or in an intrusion (known as a dike) that did not quite reach the surface. Other coarser-grained SNCs probably formed in more deep-seated locations such as magma chambers.

Like Earth rocks, SNC meteorites seem to have originated in a variety of rock-forming processes. For example, the SNC called EETA79001 displays a history of great geological complexity (see photo at left) although it weighs barely one pound.

It's the only known meteorite (of any kind) that shows igneous layering of two distinct rock types. One layer is quite coarse-grained and the other relatively fine-grained. Dispersed within the fine-grained rock are a few large clumps of crystals. These were either incorporated into the original magma from another magma that had these crystals suspended in it, or they were pieces of local rock torn off when the magma flowed through it. The texture and chemistry of EETA79001 suggest that it formed within a thick lava flow, and the two layers (the coarse-grained layer and the fine-grained layer with coarse clumps) most likely formed during two separate eruptions of lava from the same vent.

The SNC meteorites have given planetary scientists an exciting look at the composition of Mars rocks and Martian eruptive processes. Just as fascinating, they have also shown that volcanism occurred on Mars in the past 1.3 billion years and very likely as recently as 180 million years ago. In contrast to Moon rocks and common meteorites, SNCs are very young. Lunar rocks have ages that range from about 3 billion years to greater than 4.4 billion years. On Earth, rocks range in age from those that formed about 4 billion years ago to those so new they are too hot to touch.

Most crustal rocks on Earth, however, are less than 600 million years old. If the youngest SNC age, about 180 million years, is correct, then it's possible that Mars still exhibits volcanic activity. In geologic terms, 180 million years is a relatively short period. If volcanism occurred on Mars so recently, the planet may still be

M. Robinson, Univ. of Hawaii

volcanically active. Thus high-resolution cameras and temperature measurements on future Mars orbiters or landers may well uncover signs of recent eruptions.

SNCs and Future Missions to Mars

Scientists have learned a lot from the SNC meteorites, and many new questions have arisen. The two most pressing are where on Mars did the SNC meteorites come from and were they all ejected in the same impact event? No definitive answers are possible, but there has been much speculation. Knowing where the rocks originated would be incredibly valuable, because then planetary scientists could begin to determine the absolute ages of the different areas on Mars.

A relative timeline already exists, compiled by carefully counting the number of impact craters per square kilometer of surface. Areas with many craters have recorded more hits from space, so the surface must be older. A big unknown, however, is the rate at which comets and meteors impact Mars. But if scientists can get actual rock samples from known locations, they can date the samples and thus calibrate the relative timeline deduced through crater counting. With such a calibration, planetary scientists could assign absolute ages to all areas of the Martian surface. Unfortunately, no one has yet located the "home base" for any SNC meteorite.

The SNC meteorites have shown that the surface of Mars contains regions that are relatively young, possibly as young as 180 million years. They have also demonstrated that Mars possesses geologically complex rocks that have undergone processes like those on Earth. This important result underscores the value of future Mars sample return missions for better understanding the geology of the Red Planet. In the meantime, dozens or perhaps hundreds more SNCs may be lying about on Earth. Certainly only a tiny fraction of the SNCs that have fallen to Earth have been found. Who knows what these yet-to-be-found SNCs could tell us about Mars and its past? ☐

Mark Robinson is a planetary geologist at the U.S. Geological Survey in Flagstaff, Arizona. Meenakshi Wadhwa is a research scientist at the Scripps Institution of Oceanography in La Jolla, California.

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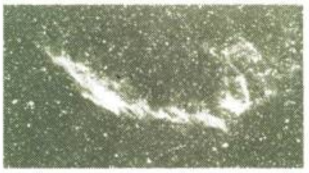

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2" (1.83" mirror)(see photo above) **$169.50**

DEEP-SKY ASTROPHOTOGRAPHY

SR-V 3200 NEW FILM

FILM HYPERSENSITIZATION KITS†

LUMICON HYPER-KITS™ yield 3-15x film speed gain in long exposures. They are safe & simple to use. Easy HYPER-KIT includes a chamber with all controls and fittings, thermometer, a refillable cylinder of non-flammable forming gas & hand-operated vacuum pump.

†U.S. Patent 4,473,636

MAKE YOUR OWN HYPERED FILM

MODEL 300 HYPER-KIT sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds **$325**

MODEL 600 HYPER-KIT (See photo) Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates **$395**

MODEL 1200 HYPER-KIT is for 4X5" plates and film up to 5X7". Has 2 gas cylinders and includes temperature controller **$595**

Temperature controller for any HYPER-KIT **$75**

Electric Vacuum Pump, Model R-10 **$325**

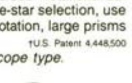
GUIDE OFF-AXIS FOR LOVELY ASTROPHOTOS

All **LUMICON EASY-GUIDER™** off-axis guiders† have both radial and 360° rotational adjustments for 5X easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms for bright guide-stars.

†U.S. Patent 4,448,500

Specify Camera and Telescope type.

NEWTONIAN EASY-GUIDER™



Full aperture. Installs in seconds. Specify 2" or 1¼".

NEWTONIAN EASY-GUIDER **$189.50**
48mm Coma corrector/field flattener **$285**
3X Relay Diagonal (see photo) **$99.50**
Illuminated reticle eyepiece, pulsed **$109.50**
Guider for Hasselblad **$409**, Mamiya 645 **$199**
Pentax 6X7 **add $119**; Pentax 645 **add $139**

CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Cynamax-8. Includes 50mm achromatic lens for f/5.8 operation—3X shorter exposures! **Superb rich field viewing, too!**

CASSEGRAIN EASY-GUIDER **$249.00**
Adapter for Hasselblad **$225,** Mamiya 645 **$98**
Pentax 6X7 **add $119;** Pentax 645 **add $139**

GIANT EASY-GUIDER™

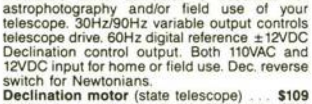
For Celestron-11, C-14, and the 10" Meade 2120. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. **Also yields unmatched Rich-Field viewing.**

GIANT EASY-GUIDER **$395.00**
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE $20) **add $99.95**
Adapter for Hasselblad **$295,** Mamiya 645**$149**
Pentax 6X7 **add $129;** Pentax 645 **add $149**

WHAT DO YOU NEED?

1. Illuminated reticle eyepiece **$99.50**
Lumicon 12mm eyepiece system has adjustable LED illumination, dual crosslines, battery pack.

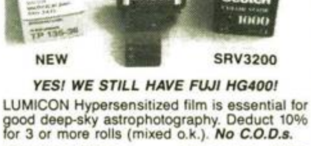
2. Cable release for long exposures **$9.95**



3. **LUMICON Digital Drive Corrector . $249**
Dual-axis drive corrector is essential for astrophotography and/or field use of your telescope. 30Hz/90Hz variable output controls telescope drive. 60Hz digital reference ±12VDC Declination control output. Both 110VAC and 12VDC input for home or field use. Dec. reverse switch for Newtonians.

Declination motor (state telescope) **$109**
Variable dec. speed drive w/built-in 5AH battery **$299**

HYPERSENSITIZED FILM



NEW SRV3200

YES! WE STILL HAVE FUJI HG400!

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.). ***No C.O.D.s.***

Film Type, 35mm	Exposures	Price
2415, Ultra-fine B&W, red sens.	36	$11.95
SR-G3200, fastest of all, color neg	24	$14.95
Kodak Ektar 1000 fast, fine grain	24	$12.95
Fuji HG400 fine grain color neg.	**24**	$14.95
Scotchrome 400, fast slide film	12	$12.95
Fujichrome RD100, fine grain slide	24	$12.95
D-19 B&W Developer	1 gal.	$6.95

LUMICON® ACCESSORIES | MEADE® TELESCOPES

TOLL-FREE ORDER LINE 1-800-767-9576 EXPERT INFORMATION 1-510-447-9570 FAX 1-510-447-9589
LUMICON, 2111 Research Drive, Suites 4-5, Livermore, CA 94550 OPEN M-F 9-5, SAT 11-3 PST

LED FLASHLIGHT . $14.95

LUMICON LUMILITE™ Red LED Flashlight

This red LED flashlight preserves night vision. It uses 2 AA cells (included!) which last 60-100 hours.

LUMILITE red LED flashlight **$14.95**

DRIVE CORRECTORS

LUMICON UNITRAK DRIVE CORRECTOR

Operate your telescopes ***anywhere!*** Use the single-axis Unitrak with a 12V DC car battery. The dual-axis drives are for photography and use either 12V DC or 125V AC.

Unitrak™ single-axis corrector	**$99.95**
LUMICON DX200 dual-axis correc.	**$249.00**
DX2BP incl. battery & charger ...	**$298.00**

Convenient rechargeable Porta-Pac battery:

12V DC Porta-Pac (5AH) & recharger	**$79.50**
12V DC Porta-Pac (12AH) & recharger	**$99.50**

48MM COLORED FILTERS

FOR EVERY NEED

Select 48mm UV, Red, Yellow, Green (ea.)	**$19.95**
48mm Cyan (absorbs red)	**$69.00**
48mm High Performance Blue (95% T)	**$49.00**
48mm Tri-Color Blue (80% T- 400nm) .	**$49.00**
48mm Ultraviolet (85% T- 370nm)	**$49.00**
Color Separation Set: cyan, red, yellow, blue	**$149**

RICH FIELD! 2° in 8" SCT

NOW ONLY

$99.50

LUMICON Rich-Field Viewer on C-8 with LUMICON 2" star diagonal and 2" eyepiece.

The LUMICON Rich-Field Viewer fits **all** commercial Schmidt-Cassegrain telescopes. It has a high-performance coated achromatic focal reducing lens with 50mm clear aperture for **totally unvignetted viewing** with 2" or 1¼" eyepieces. It is available in several combinations depending on the eyepiece and field-of-view you desire (see chart below).

LUMICON Rich-Field Viewer	**$99.50**
Giant Rich-Field Viewer (10-14") ..	**$250.00**

Optional Eyepiece	TRUE FIELD	Price
Meade 32mm Plossl	1.4°	**add $99**
Meade 32mm 2" Wide-Field†	1.9°	**add $439**
Tele Vue 40mm 2" Wide-Field†	2.4°	**add $498**

†Includes 2" enhanced aluminum Star Diagonal (may not reach focus on some telescopes).

PROTECTIVE DUST COVERS

Protect your valuable telescope optics, eyepieces and accessories with these black vinyl covers. Add $1 shipping. Deduct 10%, 2 or more sets.

1¼" O.D. plug, seals focuser	**4/$2**		
2" O.D. plug	**2/$2**	3½" O.D. plug	**$1.50**
1¼", 1⅜" ...	**3/$2**	7½"	**$10**
1½"	**2/$2**	9½", 10.4"*	**$15**
2"	**2/$2**	12½", 12⅞"* ...	**$20**
2⅛"	**2/$20**	15.6", 16"*	**$28**
5½"	**$6**	19" (DS-16)	**$35**
*Fits Odyssey		21" (Odyssey-II)	**$35**

MEADE 8" - 16" LX200 SCHMIDT-CASSEGRAINS

8" LX200
$2495

16" LX200 $14,950

NEW Meade 8" LX200 Telescopes

LX100 - includes wedge, best for photography.
LX200 - full computer control w/64K obj. mem.
NOTE: A wedge is **not** needed for visual observing with the LX200 Drive. Select f/10 or f/6.3 (no extra charge) for your Schmidt-Cassegrain.

8" **LX100** with wedge ($105 P&S)	**$2095**
8" **LX200** w/computer ($105 P&S)	**$2495**
Wedge for photographing w/8" LX200 ..	**$139**
10" **LX100** w/super wedge ($145 P&S) .	**$2895**
10" **LX200** w/computer ($145 P&S) ...	**$2895**
12" **LX200** (f/10 only)($215 P&S)	**$3995**
Super Wedge for photogr. w/10",12" LX200	**$395**
16" **LX200** f/10 w/tripod ($385 P&S) .	**$14,950**
Dew Shields: 8" .... **$119;** 10"	**$129;**
12" .... **$189;** 16"	**$289**

OTHER SCHMIDT-CASSEGRAINS

Meade 2045D 4" f/10 w/motor ($40 P&S)	**$699**
Meade 2080B 8" f/10 w/tripod, wedge, MCOG ($95 P&S)	**$1249**
Model 2120B 10" f/10 w/wedge, tripod, MCOG ($125 P&S)	**$1599**

PHOTOGRAPHY ACCESSORIES

Cassegrain EASY-GUIDER 4", 8", f/6 or f/10	**$249**
Giant EASY-GUIDER for 10"/12" f/4-f/10 .	**$395**

MEADE STARFINDERS

8" f/6
$699*

New 8" f/6 Meade Starfinder telescopes

See the Meade ad in this magazine for full descriptions. These are complete telescope systems with motor drive (equat. only), mount, finderscope and 25mm (=48X) eyepiece.

6" **f/8 Dobsonian Starfinder** ($46 P&S)	**$325**
6" **f/8 Equat. Starfinder 6**(add $79 P&S) ...	**$599**
8" **f/6 Dobsonian Starfinder** (add $59 P&S)	**$425**
8" **f/6 Equat. Starfinder 8** (add $89 P&S) ..	**$699**
10" **f/4.5 Dobsonian Starfinder** ($85 P&S) ..	**$595**
10" **f/4.5 Equat. Starfinder 10** (add $99 P&S)	**$799**
12.5" **f/4.8 Dobsonian Starfinder** ($95 P&S)	**$795**
16" **f/4.5 Starfinder 16** (ship. freight COD) .	**$2495**

*All Starfinder telescopes shipped directly from Meade to the purchaser. Please add the indicated packing & shipping charge to the price. Slightly lower P&S for payment by check. LUMICON showroom prices are $99 higher.

ACCESSORIES

LUMICON carries all Meade accessories.

LUMICON Single axis drive corrector .	**$99**
LUMICON DX200 Dual-axis drive cor.	**$249**
Meade 47M Dual-axis drive corrector with tangent arm & electric declination ..	**$475**
LUMICON DX2BP Dual-axis drive corrector with built-in battery pack	**$299**

LUMICON® SKY VECTOR™ LUMICON ACCESSORIES

Higher Performance — Lower Price LUMICON, 2111 Research Dr., #5, Livermore, CA 94550 (510) 447-9570 FAX (510) 447-9589

LOW PRICE—from $399

LUMICON SKY VECTOR FEATURES:

- "GUIDE" mode leads you to object
- Digital right ascension readout to 1 min.
- Digital decl. readout to 10 arc-min.
- 4000 pulse (0.09° accuracy) encoders
- Polar alignment ***not required!***
- Motor drive ***not required!***
- Just sight two stars to align!
- Works **equally well** for alt-azimuth telescopes like Coulter Odyssey and equatorial mounts like C-8, Meade 2080.
- **No need** to enter latitude, longitude, etc.

SKY VECTOR I™ $399

NEW! With over 220 object memory including the 110 Messier and 58 best NGC objects.

SKY VECTOR II™ $499

IMPROVED — Planets, Over 3,700 Objects! With size, magnitude and full visual description.

NGC SKY VECTOR™ $699

IMPROVED!—5500 Additions / Corrections

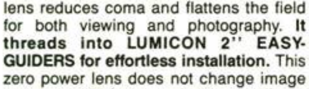
NGC-Sky Vector™
OFF ON
DIM
MODE
ENTER
UP
DOWN
LUMICON®

Improved NGC SKY VECTOR with over 12,000 object memory including the planets, complete, corrected RNGC catalogue, IC catalogue, P&K planetary catalogue, & much more!

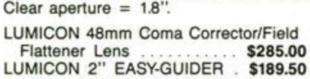
Specify Telescope Type: Meade 2045, 2080, 2120, C-8, C-11, Odyssey 8, 10, 13, 17½, Alt-Azimuth.

Ultima 8, 11 .. **add $25**, C-14 .. **add $75**

COMA CORRECTOR



Coma 1 inch off-axis 17½" f/4.5



Same field with LUMICON coma corrector; smaller, more numerous stars.

This computer-designed LUMICON 2" lens reduces coma and flattens the field for both viewing and photography. **It threads into LUMICON 2" EASY-GUIDERS for effortless installation.** This zero power lens does not change image scale nor shift focus, and all lens surfaces are multi-coated for highest efficiency. Clear aperture = 1.8".

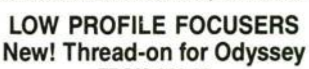
LUMICON 48mm Coma Corrector/Field Flattener Lens	**$285.00**
LUMICON 2" EASY-GUIDER .	**$189.50**
2" EASY-GUIDER (Mamiya 645)	**$199.50**
2" Adapter for Pentax 6X7 ...	**$129.00**
2" Adapter for Hasselblad .	**$229.00**
2" Adapter for Bronica SQ-A	**$175.00**
2" Extension for viewing ...	**$26.00**

2" DELUXE BARLOW

1.8x Multiplier Lens (2" Barlow)

LUMICON 1.8x Multiplier Lens (2" Barlow) **$235.00**

LARGE UV/DUST SEAL

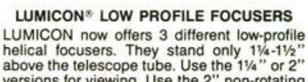


Protect the optics of your 8-14" Schmidt-Cassegrain with a UV/Dust Seal. Simply thread it onto the rear cell, then attach all normal accessories. The large size fits Meade 2120, Celestron-11 and -14 & has a high quality multi coated (removable) 72mm UV filter.

Deep-Sky Filter/Dust Seal for C-8, 2080 ...	**$119.50**
UV/Dust Deal for Celestron C-8 ...	**$39.00**
UV/Dust Seal for Meade 2080, 2045	**$39.00**
UV/Dust Seal (large) for Meade 2120	**$89.50**
UV/Dust Seal for Celestron-11, -14 .	**$89.50**

LOW PROFILE FOCUSERS New! Thread-on for Odyssey

FROM $69.50



LUMICON® LOW PROFILE FOCUSERS

LUMICON now offers 3 different low-profile helical focusers. They stand only 1¼-1½" above the telescope tube. Use the 1¼" or 2" versions for viewing. Use the 2" non-rotating focuser for convenient photography with the LUMICON 2" EASY-GUIDER™.

Select your desired base-plate shape!
Coulter Odyssey (thread-on installation), Flat, 7" OD, 9½" OD, 12½" OD, 16" OD, 21" OD.

LUMICON 1¼" Helical Focuser	**$69.50**
LUMICON 2" Helical Focuser 1½" high	**$75.00**
LUMICON Non-rotating Helical Focuser	**$129.00**
2" Astro Systems focuser, only 2" high	**$139.00**
3 handles for non-rotating focuser	**$12.95**
2"/1¼" adapter w/48mm filter threads	**$20.00**
2" LUMICON EASY-GUIDER	**$169.50**

LUMICON 50mm, 80mm SUPER-FINDER™

Visual Astronomers prefer the LUMICON 80mm SUPER-FINDER™, since hundreds of deep-sky objects, including most Messier objects, are visible directly. SUPER-FINDERS also make nice small portable telescopes. 80mm aperture, F=300mm coated achromat or 50mm, F=200mm coated achromat. Eyepieces and/or star diagonal are extra.

1¼" 50mm Finderscope **$69.50**, right-angle	**$69.50**
1¼" straight-thru 80mm SUPER-FINDER .	**$179.50**
1¼" right-angle 80mm SUPER-FINDER ..	**$189.50**
1¼" right-angle version, w/star diagonal ..	**$239.50**
25mm Cross-hair 1¼" eyepiece (12X)	**$49.00**
Large mounting rings for 80mm Finder	**$55.00**
1¼" Star Diagonal **$49**, Mounting Brackets,	**$39.50**
1¼" 45° diagonal for correct left-right views	**$59.50**

LOTS OF ADAPTERS

2" adapter for C-8, Meade 2080, etc. ..	**$29.50**
2" adapter for C-80, C-100 refractor ...	**$39.50**
2" adapter for C-70, C-80F, C-100F fluorite	**$39.50**
2" adapter for C-6, Comet Catcher, Meade 312	**$30.00**

EXTENSION TUBES

1" long 1¼" OD thread-in extension ...	**12.00**
2½" long extension (holds 1¼" filters) .	**19.50**
4½" long extension for 1¼" eyepieces	**$25.00**
3" long extension for 2" eyepieces* ..	**$26.00**
2" long extension for 2" eyepieces* ..	**$26.00**

VIEWING ADAPTERS

2"/1¼" reducing bushing, threaded 48mm*	**$25.00**
2"/T-thread adapter, threaded 48mm* ..	**$25.00**
T-thread/1¼" adapter	**$25.00**
F/10 2" or 1¼" eyepiece viewing adapter for Giant Easy-Guider	**$39.50**
Low profile star diagonal eyepiece holder	**$16.00**
Meade 2" Diagonal/Giant Easy-Guider	**$39.50**

**Threaded to hold 48mm filters.*

SKY ALMANAC

The Moon will diminish the Perseid meteor shower, but skywatchers can enjoy bright Jupiter and Saturn, and observers with scopes can zero in on Comet d'Arrest at it peaks in brightness.

by Deborah Byrd

Highlights
by Rick Shaffer

Date	Event
5	The Moon Joins Jupiter in the Scorpion. . . . . *(p. 59)*
12	The Perseids Contend with the Moon *(p. 57)*
	First Views:
29	The Moon Joins Mars and Spica . . . . *(p. 52)*
All month:	
	Comet d'Arrest at Its Brightest. . . . . *(p. 59)*
	The Pleiades Receive a Visitor . . . . . *(p. 57)*
	Saturn's Rings Come out of Hiding. . *(p. 60)*
	Observer's Challenge: Pluto's Last Gasp of '95. . . . . *(p. 61)*
	The Starry Sky: Capricornus . . *(p. 58)*

August nights have plenty to offer those of us who watch the skies. The warm evenings combined with the bright stars of the summer Milky Way seemingly draw us outside, where we can marvel at the beauty of the night sky better than perhaps any other time of year.

This is the best time of year to stand outside under a dark sky, on a night when the Moon doesn't interfere, and look toward the center of the Milky Way Galaxy. The center of our Galaxy lies in the direction of the constellation Sagittarius. In ancient mythology, this constellation represented an archer and is often pictured as a Satyr, with a horse's lower body and the chest, shoulders, and head of a man.

Modern stargazers generally pick out this constellation by its most prominent pattern of stars, an asterism known as the Teapot. Second-magnitude Nunki marks the top of the teapot's handle. Third-magnitude Kaus Borealis forms the top of the teapot's lid. Another 3rd-magnitude star, Gamma Sagittarii, lies at the tip of the spout. To some, the fiery star clouds of the Milky Way resemble clouds of steam rising from the spout of the teapot.

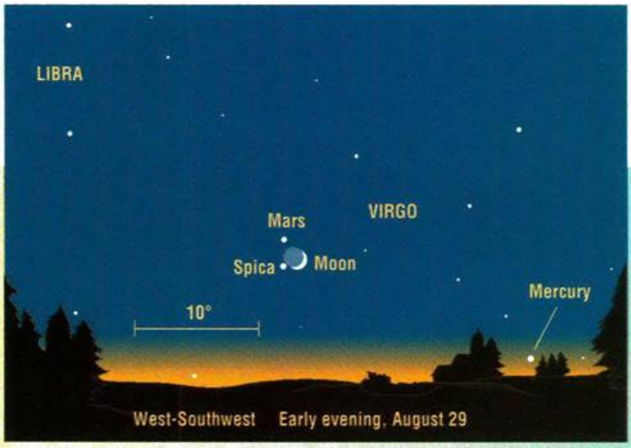
The exact direction to the center of the Galaxy lies about 5° west of the teapot's spout. Wonders populate this whole region of sky. You can't fail to be impressed if you simply scan here with binoculars, even if you have no idea what you are seeing. You will find an amazing collection of star clouds and clusters, and both bright and dark nebulae.

This summer's evening sky also offers a number of planets. After sunset in the west-southwest you can see **Mars**, the world whose climate most resembles Earth's. At magnitude 1.4, it is the brightest object near the Moon on August 1. On that date, it lies 17° to the lower right of the bright star Spica, in the constellation Virgo. The apparent distance between the star and planet closes as the month passes. By August 29 — when the Moon again sweeps through that part of the sky — Mars, Spica, and the Moon make a very compact group in the western twilight sky.

Mars lies about 180 million miles away this month, nearly as far as it can be. It therefore appears small and nearly featureless through a telescope, a ruddy disk measuring 5" across.

The second-brightest (and largest) planet in our solar system now lies about 450 million miles away. But **Jupiter** is so big that even at that distance, it's a wonderful sight through a telescope. It's easy to find in the south as night begins.

First Views:
The Moon Joins Mars and Spica



Twice this month the Moon passes close to Mars. On August 1, it comes within 2° of the Red Planet. Unfortunately for those in North America, this happens during the late morning hours, after the two have set. By the time darkness falls and the two come into view, they lie about 7° apart in the western sky. The waxing crescent Moon then appears to the left of Mars.

As the days pass, the Moon quickly exits the scene while Mars remains in the western twilight sky. But the bright star Spica approaches the planet as the two sink toward the horizon. By the 27th, these two objects lie just 2° apart. The scene gets more interesting two days later when the Moon on its monthly swing returns to the vicinity. Watch on the evening of the 29th when it lies less than a degree from Mars, which in turn remains about 2° from Spica.

Although the view looks best with the naked eye or binoculars, the trio is also worth examining with a telescope, where you can compare the objects' colors. The Moon shines by reflected sunlight and looks essentially white. Spica, a much hotter star than the Sun, radiates more blue light, and you should be able to detect a bluish tinge to its light. Finally Mars, with its distinct ruddy hue, contrasts with the other two nicely. — *Rick Shaffer*

AUGUST

1 The Moon passes 2° south of Mars, 11 a.m. EDT

3 First Quarter Moon is at 11:16 p.m. EDT

5 The Moon passes 2° north of Jupiter, 4 p.m. EDT (page 59)

8 The Moon is at perigee (225,473 miles from Earth), 9:53 a.m. EDT
The Moon passes 5° north of Neptune, midnight EDT

9 The Moon passes 6° north of Uranus, 8 a.m. EDT
Mercury passes 1.1° north of Regulus, noon EDT
Asteroid Aquitania is at opposition

10 Comet d'Arrest is at perigee (37.8 million miles from Earth)
Full Moon is at 2:15 p.m. EDT
Earth passes through Saturn's ring-plane, 5 p.m. EDT (page 60)

12 Perseid meteor shower peaks (page 57)

13 The Moon passes 5° north of Saturn, 7 a.m. EDT

17 Last Quarter Moon is at 11:04 p.m. EDT

20 The Moon is at apogee (251,508 miles from Earth), 7:42 a.m. EDT
Venus is in superior conjunction, 8 p.m. EDT

23 Asteroid Pallas is in conjunction with the Sun

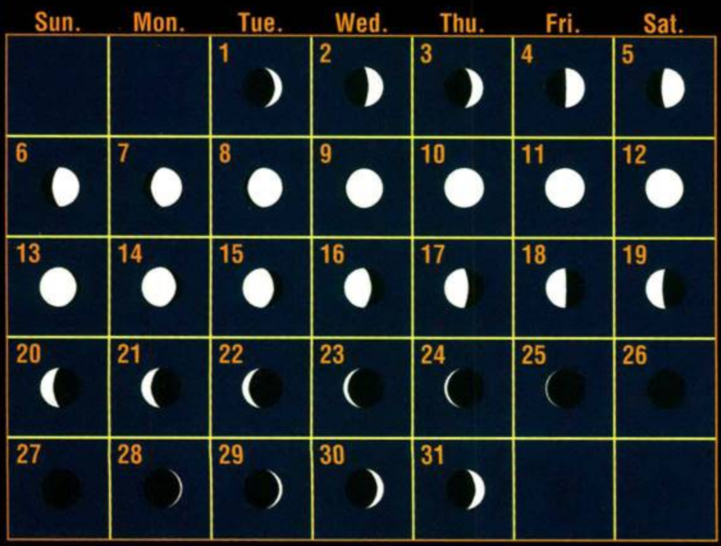
25 Asteroid Vesta is in conjunction with the Sun

26 New Moon is at 12:31 a.m. EDT

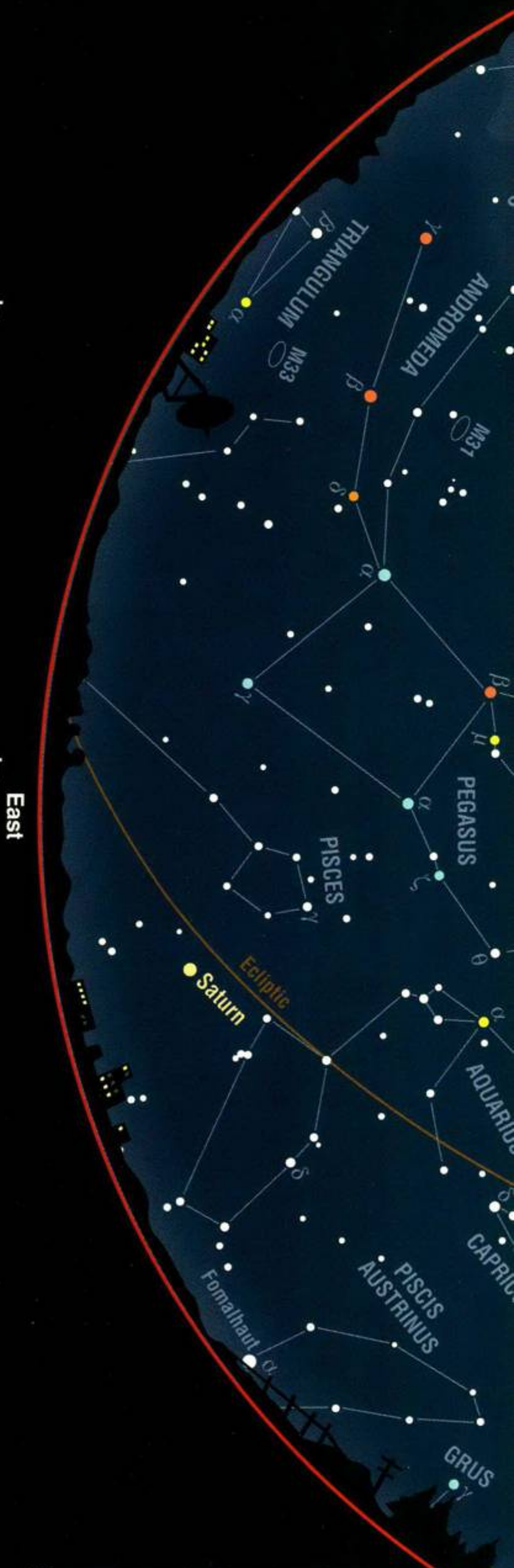
27 Mars passes 2° north of Spica, 9 a.m. EDT

28 The Moon passes 1.8° south of Mercury, 3 a.m. EDT

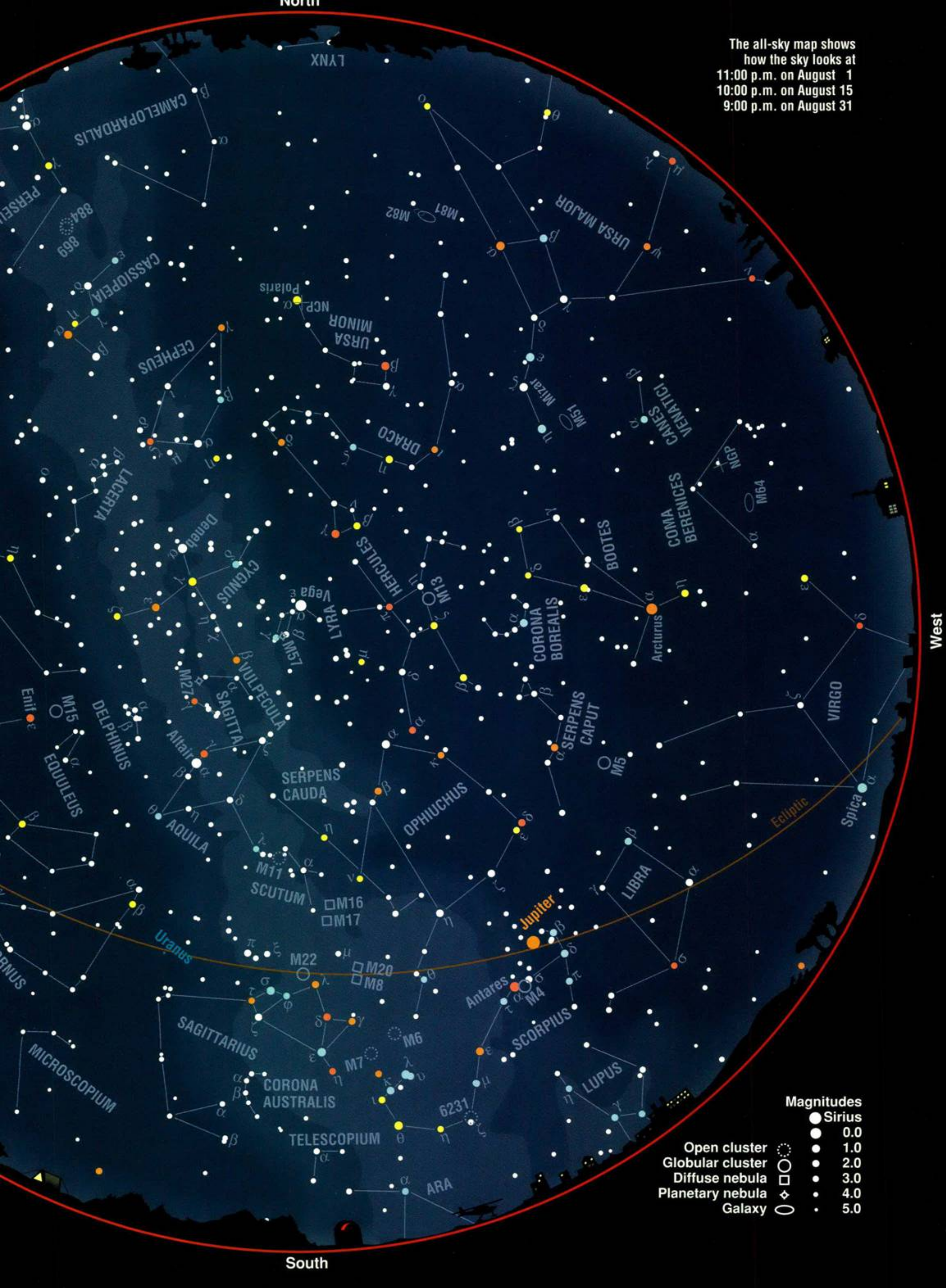
29 The Moon passes 0.2° south of Mars, midnight EDT (page 52)



Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		



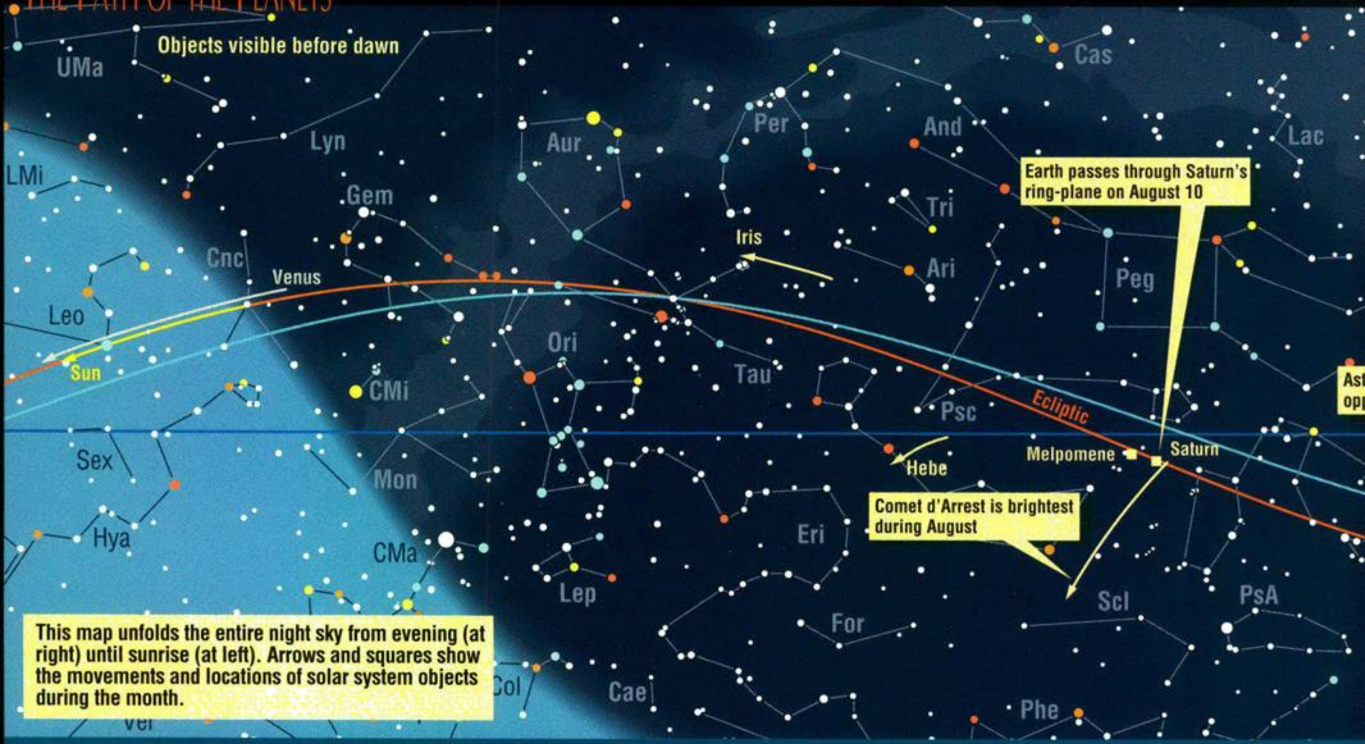
This map portrays the sky at times shown in the upper right corner of the page. Located just outside the map are the four directions: north, south, east, and west. To find stars above your horizon, hold the map overhead and orient it so a direction label matches the direction you're facing. The stars above the map's horizon now match what's in the sky.


North
LYNX
CAMELOPARDALIS
PERSEUS
869
884
CASSIOPEIA
Polaris
NCP
URSA MINOR
CEPHEUS
LACERTA
DRACO
M81
M82
URSA MAJOR
Mizar
M51
CANES VENATICI
NGP
M64
COMA BERENICES
BOOTES
Arcturus
CORONA BOREALIS
HERCULES
M13
Vega
LYRA
M57
Deneb
CYGNUS
VULPECULA
M27
SAGITTA
Altair
AQUILA
DELPHINUS
EQUULEUS
Enif
M15
SERPENS CAUDA
OPHIUCHUS
SERPENS CAPUT
M5
VIRGO
Spica
Ecliptic
LIBRA
Jupiter
Antares
M4
SCORPIUS
M11
SCUTUM
M16
M17
Uranus
M22
M20
M8
M6
M7
SAGITTARIUS
CORONA AUSTRALIS
MICROSCOPIUM
TELESCOPIUM
6231
LUPUS
ARA
South
West

The all-sky map shows
how the sky looks at
11:00 p.m. on August 1
10:00 p.m. on August 15
9:00 p.m. on August 31

Magnitudes		
	●	Sirius
	●	0.0
Open cluster ⁘	●	1.0
Globular cluster ○	●	2.0
Diffuse nebula □	•	3.0
Planetary nebula ✧	•	4.0
Galaxy ⬭	·	5.0

THE PATH OF THE PLANETS

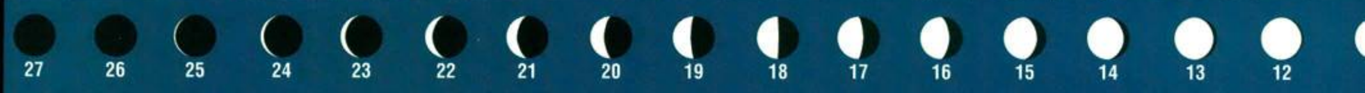

UMa
LMi
Lyn
Gem
Aur
Per
Cas
And
Lac
Tri
Iris
Ari
Peg
Cnc
Venus
Leo
Sun
Ori
CMi
Tau
Psc
Ecliptic
Ast
opp
Sex
Mon
Hebe
Melpomene
Saturn
Hya
CMa
Lep
Eri
Scl
PsA
For
Cae
Col
Vel
Phe

Objects visible before dawn

Earth passes through Saturn's ring-plane on August 10

Comet d'Arrest is brightest during August

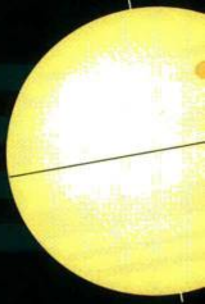
This map unfolds the entire night sky from evening (at right) until sunrise (at left). Arrows and squares show the movements and locations of solar system objects during the month.


27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12

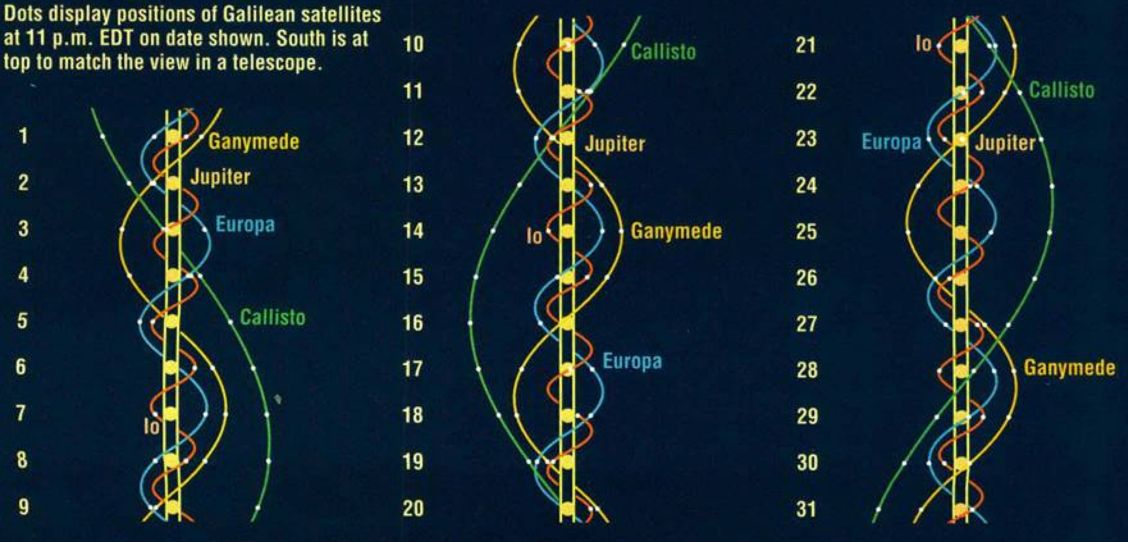
To locate the Moon in the sky, draw a line from the phase shown for the day straight up to the curved light-blue line.

10"

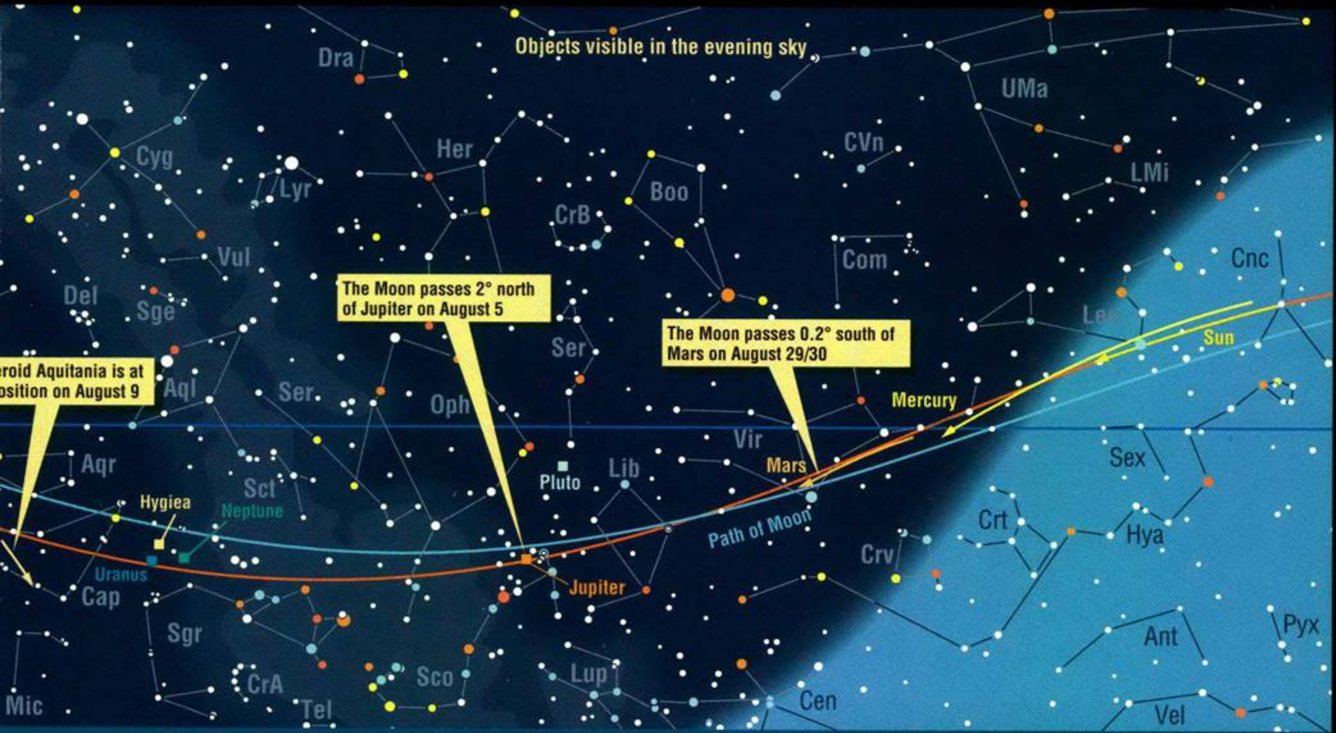
PLANETS	MERCURY	MERCURY	VENUS	MARS	JUPITER
Date	August 15	August 31	August 15	August 15	August 15
Magnitude	–0.4	0.1	–3.9	1.4	–2.2
Angular Size	5.3"	6.2"	9.6"	4.8"	39.6"
Illumination	86%	69%	100%	93%	99%
Distance (AU) from Earth	1.268	1.084	1.730	1.937	4.979
Distance (AU) from Sun	0.422	0.466	0.718	1.559	5.316
Right Ascension (2000.0)	10h43.1m	12h07.6m	9h31.8m	12h55.6m	16h16.1m
Declination (2000.0)	9°11'	–2°05'	15°57'	–5°51'	–20°43'



JUPITER'S MOONS



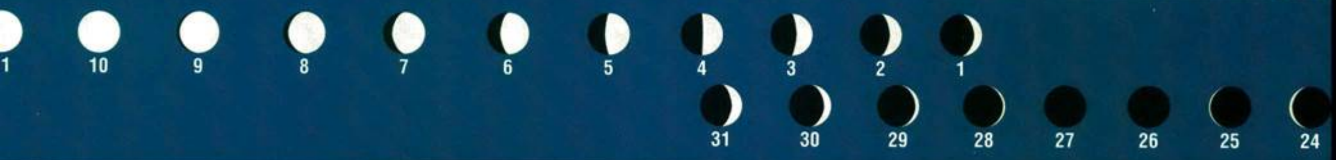
Dots display positions of Galilean satellites at 11 p.m. EDT on date shown. South is at top to match the view in a telescope.


Objects visible in the evening sky
Dra
UMa
Cyg
Lyr
Her
CVn
LMi
Boo
CrB
Vul
Com
Cnc
Del
Sge
Leo
Sun
Ser
Aql
Ser
Oph
Mercury
Vir
Sex
Aqr
Pluto
Lib
Mars
Hygiea
Neptune
Sct
Crt
Hya
Path of Moon
Uranus
Cap
Jupiter
Crv
Sgr
Pyx
Ant
CrA
Sco
Lup
Mic
Tel
Cen
Vel

The Moon passes 2° north of Jupiter on August 5

The Moon passes 0.2° south of Mars on August 29/30

eroid Aquitania is at
osition on August 9


1
10
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31
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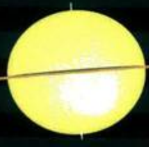
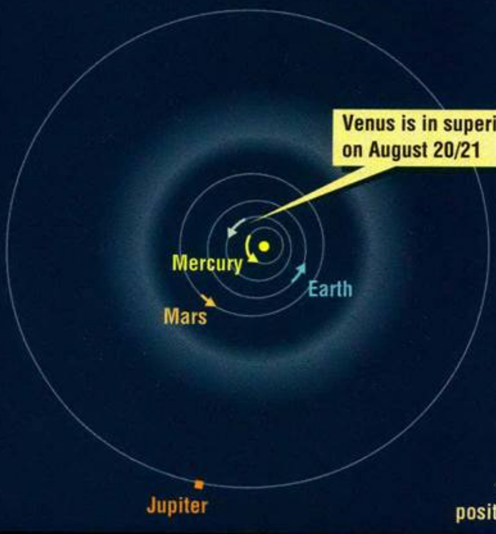
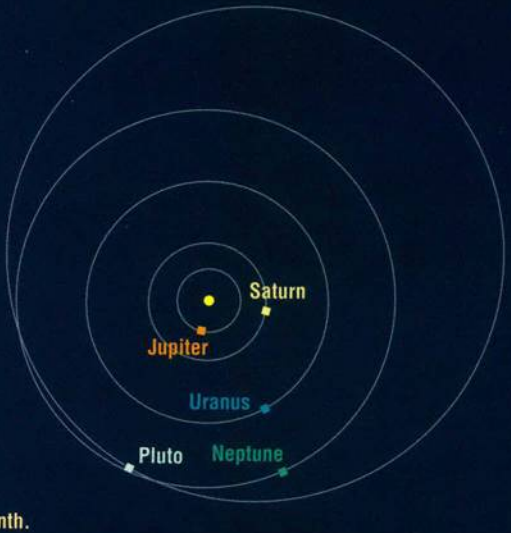


SATURN	SATURN	URANUS	NEPTUNE	PLUTO
August 1	August 31	August 15	August 15	August 15
1.0	0.8	5.7	7.9	13.7
18.7"	19.2"	3.7"	2.3"	0.1"
100%	100%	100%	100%	100%
8.888	8.636	18.797	29.273	29.730
9.622	9.613	19.726	30.169	29.851
23h42.5m	23h36.1m	19h59.2m	19h40.9m	15h54.5m
–4°20'	–5°07'	–21°12'	–20°52'	–6°35'

THE PLANETS IN THEIR ORBITS


Mercury
Earth
Mars
Jupiter

Venus is in superior conjunction on August 20/21


Saturn
Jupiter
Uranus
Pluto
Neptune

Arrows and dots represent planets' positions during the month.

Jupiter shines at magnitude –2.2 this month among the background stars of Scorpius. It becomes stationary in front of that constellation on August 2 and afterward resumes its normal, slow eastward motion. This is a sign that Earth is now moving well ahead of Jupiter as the two planets orbit the Sun and the best time of year to view this planet is coming to a close. Look for it and Antares, the brightest star in Scorpius, near the Moon on August 5.

The outermost planet, **Pluto**, lies about 15° north-northwest of Jupiter. Located in Libra, Pluto shines at magnitude 13.7, which means you'll need at least an 8-inch telescope to see it. Like Jupiter, Pluto becomes stationary this month (on the 11/12th) and afterward resumes its even slower eastward motion.

Uranus and **Neptune** begin these August evenings in the east after sunset. Uranus shines at magnitude 5.7 and now lies in far eastern Sagittarius. Neptune glows at magnitude 7.9 and also resides in Sagittarius. Both planets are well placed for observing during most of the night. Uranus can just be seen with the naked eye from a dark site, but it's easier to pick out first with binoculars. A telescope reveals it as a blue-green disk measuring 3.7" across. When seen in a telescope, Neptune appears as a blue-gray dot only 2.3" across.

Saturn rises in mid-evening as August begins, and in the evening twilight by month's end. It will reach opposition next month, when Earth passes between it and the Sun. Thus it is now nearly at its closest, and therefore brightest, of the year, shining at magnitude 0.9.

On August 10, Earth passes through the plane of Saturn's rings for the second time this year. In May we passed from the north to the south side of the rings. Since then, we have been looking toward the rings' unilluminated side. After the 10th, the north face of the rings again becomes visible, and we can see the sunlit side of the rings

The Perseids Contend with a Bright Moon

Larry E. Steenhoek

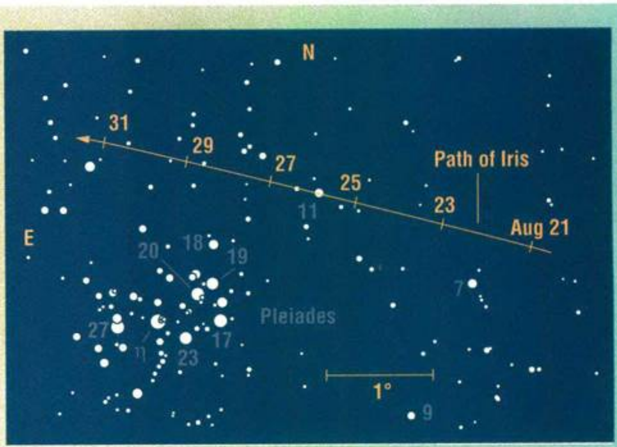
Everyone's favorite meteor shower, the Perseids, peaks this year on the night of August 12/13. Unfortunately the Moon resides in the sky at the same time, having been full just two days before, so you won't have a dark sky to enjoy the shower at any time of that night. On the positive side, the Perseids tend to be bright, so even with moonlight washing the sky, you still should be able to see many meteors.

Perseid meteors originate as dusty debris spewed out by Comet Swift-Tuttle as it travels around the Sun. Each year in mid-August, Earth runs into this cosmic debris and our atmosphere incinerates the tiny particles, producing the flashes of light.

In most years, you can expect to see 50 or 60 meteors per hour at the shower's peak. This year, with the Moon in the way, you'll be lucky to see half that many. Still the Perseids diluted by moonlight are better than most other showers at their peak, so it's worth heading out to look for them.

To enjoy the Perseids to the fullest, watch after midnight from an observing site that offers a clear view of most of the sky. Bring along a sleeping bag or blanket to ward off the cold and a thermos of hot coffee or tea and some snacks to stay alert. It also helps to bring along binoculars to examine the smoke trails that many of the brighter Perseids will leave behind. *— R.S.*

The Pleiades Receive a Visitor



A relatively inconspicuous member of the solar system, asteroid 7 Iris, grows more prominent in late August. Its prominence, however, has less to do with its brightness (it glows around magnitude 9.0) and more to do with its proximity to the glorious Pleiades star cluster. Iris passes just 1° north of the cluster between about August 27 and 31.

To find the 130-mile-diameter asteroid, first locate the Pleiades in the constellation Taurus. The cluster is well up in the east during the after-midnight hours. Then use the map to star hop to Iris (positions are shown for 4 a.m. EDT, 3 a.m. CDT, 2 a.m. MDT, and 1 a.m. PDT). Because a lot of stars populate this area, you may not be able to pinpoint the asteroid immediately. If that's the case, sketch the area and come back a night or two later. The 9th-magnitude "star" that has changed position is Iris.

Over the next several months, Iris will grow brighter as it makes its way through the stars of Taurus. By opposition in late November, it will nearly reach naked-eye visibility at magnitude 6.8. *— R.S.*

COORDINATES FOR IRIS

Date	R.A. (2000)	Dec.
August 21	3h32.0m	24°49'
August 23	3h35.7m	25°02'
August 25	3h39.3m	25°14'
August 27	3h42.8m	25°26'
August 29	3h46.3m	25°38'
August 31	3h49.7m	25°48'

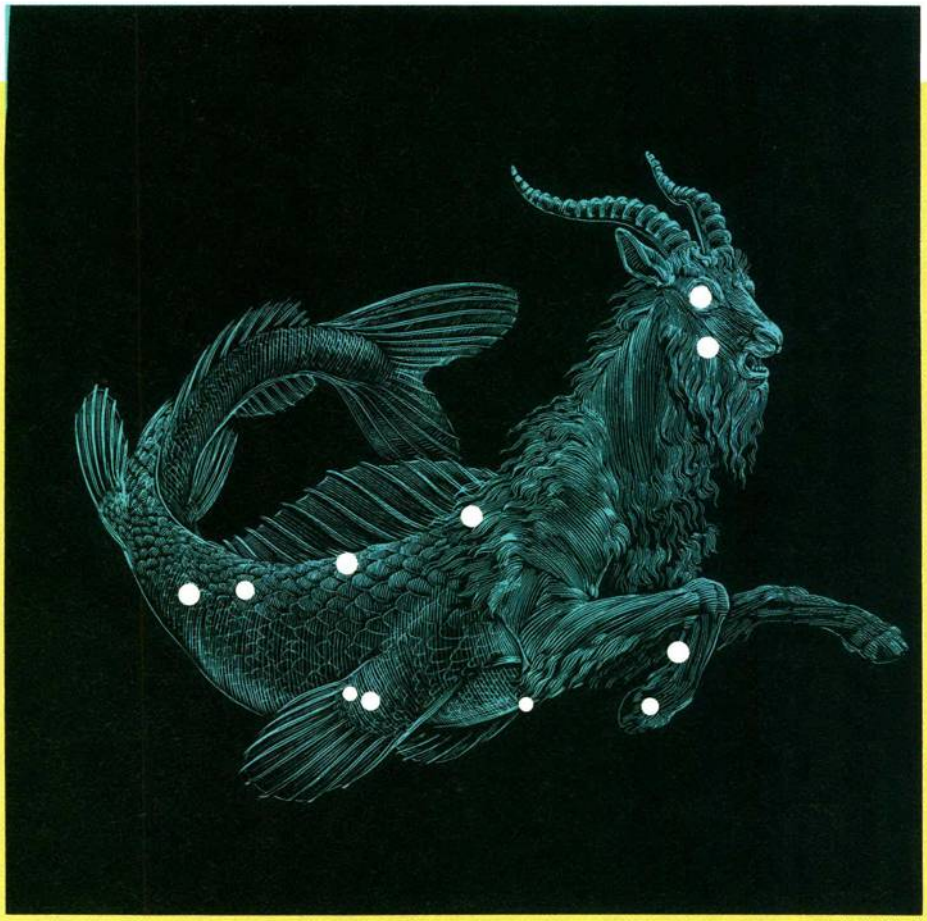
until November. That's when Saturn's ring-plane intersects the plane of the planet's orbit around the Sun, and sunlight begins falling on the south face of the rings for the first time in fifteen years. From then until February 1996, we will once again see the unilluminated face of the rings. That's when Earth crosses Saturn's ring-plane for the third time in a year, and for the last time this century. (For more on the ring-plane crossing, see "The Vanishing Rings of Saturn," June 1995.)

You might be able to glimpse **Mercury** very low in the west after sunset in the last days of August, particularly if you use binoculars. Look for it no later than half an hour after sunset. It lies just above the young crescent Moon on the evening of the 27th and about 10° to the Moon's lower right on the 28th. Mercury then shines at magnitude 0.0. It will fade in brightness but appear slightly higher in the west after sunset before its greatest eastern elongation on September 8/9.

The brightest planet, **Venus**, can't be seen this month. It is in superior conjunction, traveling more or less behind the Sun as seen from Earth, on August 20/21.

Perhaps the most anticipated August event doesn't involve viewing the planets, however, but watching the annual peak of the Perseid meteor shower. Both in August 1993 and last August, skywatchers waited eagerly

The Starry Sky: **Capricornus**



Keith Ward

This month, look for the zodiacal constellation Capricornus the Sea Goat. It lies in the southeast around 10 p.m. and wheels across the southern sky throughout the night. Capricornus is often depicted with the head and body of a goat and the tail of a fish. This unlikely creature has been around for a long time and in many cultures. Its image has been found on stones from the ancient country of Mesopotamia. The Sumerian name for the constellation means goat-fish.

In Greek mythology, Capricornus was associated with the quintessential boy-god Pan. One day, Pan came upon a group of lovely nymphs and goddesses, laughing and playing in a field. To impress them, he transformed himself into a goat and, with a mighty leap, plunged into a nearby stream. The bottom part of his body instantly turned into a fish's tail. The king of the gods Zeus — no stranger to pranks himself — was so amused by this caper that he transported the sea goat into the heavens.

Capricornus is a somewhat elusive constellation, consisting mainly of 4th- and 5th-magnitude stars that, if you are standing in the glare of streetlights or porchlights, twinkle at the limit of visibility. And yet, because Capricornus contains an asterism, a noticeable pattern of stars, you can find the constellation easily in a slightly darker sky. This asterism has a roughly triangular shape, very much like the shape of an arrowhead. The point of the arrowhead aims more or less down toward the southern horizon, no matter what time of night you look for it.

The constellation contains three particularly noticeable stars, all located within the arrowhead asterism. The Alpha star in this constellation is not the brightest. Alpha Capricorni, or Algedi, lies in the northwest corner of the arrowhead asterism. It is a wide optical double whose components shine at magnitudes 3.6 and 4.2. In theory you can split these stars, in other words see them as two stars, with the naked eye. You can split them easily with binoculars. The brighter star of the pair, Alpha^2, lies 95 light-years from Earth. The fainter star, or Alpha^1, has an estimated distance of 2,000 light-years.

Not far from Algedi on the sky's dome is the Beta star of this constellation, Dabih. This star is also a double, and some people claim to see both stars with the naked eye. Again, binoculars show them easily.

The brightest star in Capricornus is Deneb Algedi, or Delta Capricorni. It shines at magnitude 2.9 in the eastern corner of the arrowhead. The name Deneb, a recurring star name, always means tail. In this case the star represents the sea goat's fishy tail.

Deneb Algedi is a blue-white star with a distance of 37 light-years. It is an eclipsing binary system whose brightness varies slightly between magnitude 2.81 and 3.05 with a period of just over a day. Deneb Algedi's brush with fame came on the night of September 23, 1846. On that night, the planet Neptune was found 4° northeast of this star.
— Deborah Byrd

Comet d'Arrest at Its Brightest

A well-known periodic comet comes to prominence this month, appearing near naked-eye visibility and putting on a good show in binoculars and telescopes.

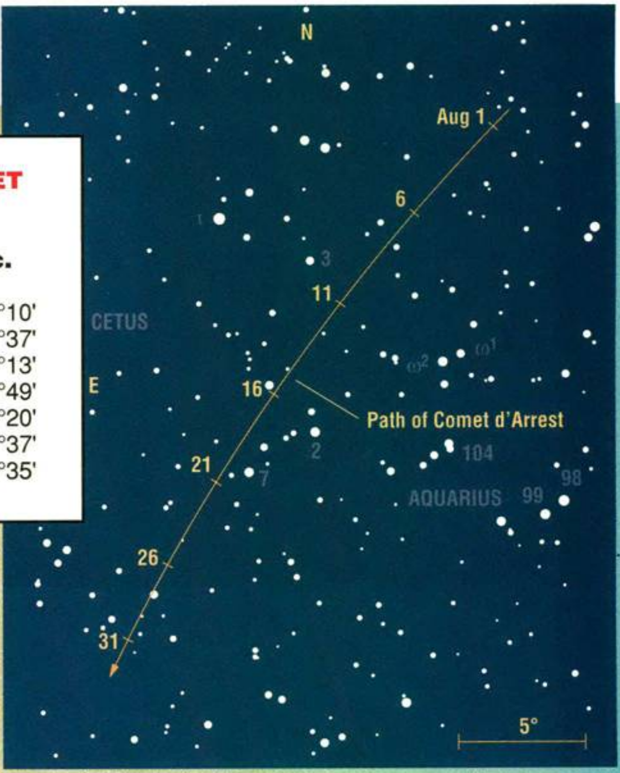
Comet d'Arrest was discovered in 1851 by Heinrich d'Arrest, who had gained a measure of fame in 1846 by helping Johann Galle discover Neptune. The comet, which orbits the Sun every 6.5 years, made an impressive return in 1976, when it reached naked-eye visibility. This promises to be the best return since then.

Comet d'Arrest begins the month as a 7.5-magnitude fuzzball in eastern Aquarius, only about 2° southwest of the bright planet Saturn. It moves rapidly to the southeast, passing through Cetus and ending the month in northern Sculptor. It peaks in brightness around mid-August, when it is expected to glow near magnitude 6.5, and begins to fade slowly after that.

The best time to look for d'Arrest is in the latter part of the month, when the Moon is out of the sky. Expect it to look fuzzy, perhaps with a central condensation. If the comet shows a tail at all, it will be a short one because d'Arrest currently lies a long way (over 1.3 AU) from the Sun. The finder map and table of coordinates show the comet's positions at 11 p.m. EDT, 10 p.m. CDT, 9 p.m. MDT, and 8 p.m. PDT. — *R.S.*

COORDINATES FOR COMET D'ARREST

Date	R.A. (2000)	Dec.
August 1	23h34.4m	–5°10'
August 6	23h47.5m	–8°37'
August 11	23h59.6m	–12°13'
August 16	0h10.5m	–15°49'
August 21	0h20.1m	–19°20'
August 26	0h28.2m	–22°37'
August 31	0h34.8m	–25°35'



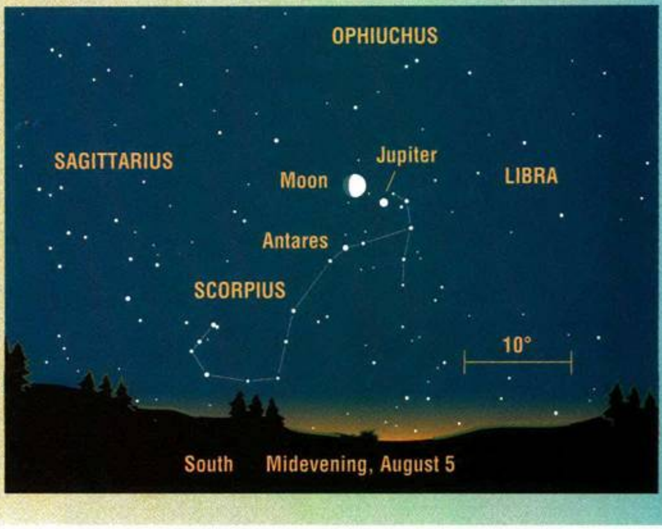
The Moon Joins Jupiter in the Scorpion

With Venus lost in the Sun's glare all month, Jupiter reigns as the brightest object in the sky after the Sun and Moon. And with it located almost due south during dusk and not setting until after midnight, the planet dominates the evening sky. Look in particular on the evening of August 5, when the waxing gibbous Moon passes just 2° north of it. The planet lies in a star-rich region of northern Scorpius, about 5° north of the bright red supergiant star, Antares.

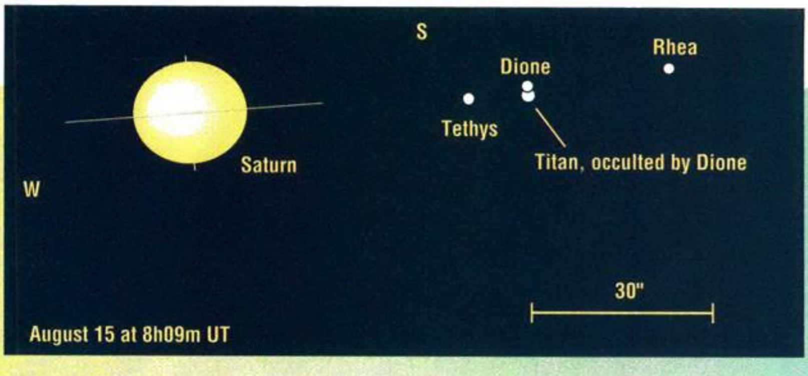
Observers with telescopes can spend hours on Jupiter. The light-colored zones alternating with the darker belts are fascinating enough, but the regions where the two meet can be particularly rewarding. The belts rocket around Jupiter between 300 to 400 miles per hour faster than the zones, creating a lot of turbulence. Occasionally a particularly strong upthrust in a zone will form a bluish tendril overlying a belt. These are called festoons, and they can come and go in a matter of days.

Also stay alert for the Great Red Spot, a massive high-pressure system that lies between the South Equatorial Belt and South Tropical Zone. Although not as prominent as its name might imply, you should be able to spot it quite easily during the half of the time it lies on Jupiter's visible hemisphere.

All this activity makes for an ever-changing viewing experience. To record those changes and improve your observing skills at the same time, you might consider drawing what you see in the eyepiece. If you're just starting out with a modest telescope, try sketching your impressions of Jupiter's entire disk. As your experience increases or you move to a larger scope, however, you may find that Jupiter presents too much detail to record at any one time. In that case, you can make a strip-drawing of only one belt and zone at a time. — *R.S.*



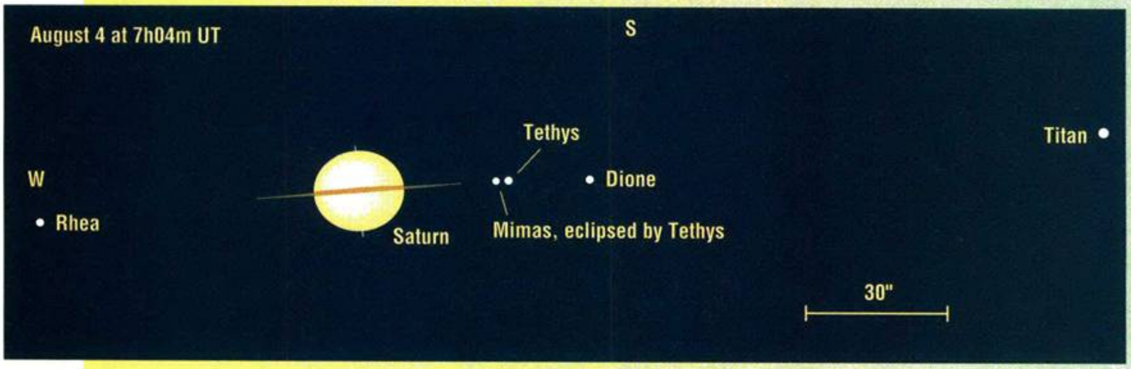
Saturn's Rings Come out of Hiding



If you've been following Saturn in a telescope so far this year, you know that its rings now appear very close to edge-on. When Earth passed through the ring-plane of Saturn last May, the thin rings disappeared from view. For the past few months, observers have seen a ghostly ring instead of the normally expansive ring system because the Sun and Earth have been on opposite sides of the rings. Rather than being lit directly by sunlight, the rings were lit by sunlight reflected from Saturn and filtering through the rings themselves.

That's the way things stand at the beginning of August, but on August 10, Earth once again passes through the ring-plane. After that both the Sun and Earth lie on the same side of the rings, and we see the fully illuminated north face of the rings again. Still the rings are nearly edge-on to our line of sight, so they appear as a bright line crossing the disk of the planet.

One favorite occupation for Saturn-watchers around the time of ring-plane crossing is to observe eclipses and occultations of its satellites. Lots of them occur this month, and with Saturn now visible for much of the night, a healthy number can be seen from any given location. The table lists all the events visible from North America during August. Perhaps the best occur on the 2nd, when Tethys eclipses Mimas and the light from this satellite drops 65 percent, and on August 14, when Titan disappears into the shadow of Saturn.
— *R.S.*



EVENTS OF THE SATURNIAN SATELLITES

Date	Begin Time	End Time	Event	Type of Event	Light Loss	Distance
August 2	9h44.4m	9h46.4m	Tethys eclipses Mimas	Partial	65%	3.0
August 4	7h02.2m	7h04.9m	Tethys eclipses Mimas	Partial	61%	3.0
August 5	5h01.5m	5h05.1m	Mimas occults Rhea	Partial	1%	2.9
August 6	4h20.4m	4h23.0m	Tethys eclipses Mimas	Partial	56%	3.0
August 8	1h38.7m	1h41.4m	Tethys eclipses Mimas	Partial	46%	3.0
August 8	5h25.0m	5h26.0m	Dione occults Enceladus	Partial	2%	3.4
August 9	6h40.9m	6h42.5m	Enceladus occults Rhea	Annular	9%	2.5
August 11	10h32.5m	10h34.2m	Rhea occults Enceladus	Partial	5%	3.6
August 12	9h00.0m	9h04.0m	Mimas occults Enceladus	Partial	39%	3.0
August 14	5h11.8m	6h49.6m	Mimas occults Titan	Annular	1%	2.6
August 14	9h09.4m	9h27.2m	Saturn eclipses Titan	Disappearance	—	1.9
August 15	3h02.2m	3h59.6m	Dione occults Titan	Annular	5%	4.5
August 15	7h48.6m	8h28.4m	Dione occults Titan	Partial	4%	6.0
August 16	11h52.0m	11h54.0m	Rhea occults Enceladus	Total	13%	2.8
August 20	10h38.5m	10h39.9m	Mimas occults Dione	Annular	11%	2.2
August 23	5h48.8m	5h50.0m	Mimas occults Rhea	Partial	3%	2.6
August 23	13h24.5m	13h37.9m	Dione occults Rhea	Partial	20%	6.0
August 25	1h47.9m	1h49.2m	Tethys occults Enceladus	Partial	20%	3.0
August 28	10h46.5m	10h47.5m	Enceladus occults Mimas	Partial	12%	2.4

Begin Time: Universal time at beginning of event. (Subtract 4 hours to convert to EDT, 5 hours for CDT, 6 hours for MDT, and 7 hours for PDT.) **End Time:** Universal time at end of event. **Event:** The nature of the event and the objects involved. **Type of event:** Whether the event is partial, total, or annular. **Light Loss:** For eclipses — the percent of light lost by the eclipsed satellite at midevent; For occultations — the percent of light lost from the combined light of both satellites at midevent. **Distance:** The apparent distance of the satellite from Saturn's center expressed in Saturnian equatorial radii.

for the Perseids in hopes of seeing a meteor storm. That was because the comet that spawns the Perseids, Comet Swift-Tuttle, returned to the Sun's vicinity in late 1992.

The history of meteor observing shows that when a parent comet is nearby, the offspring meteor shower can be spectacular. Thus in the past two years, the Perseid meteor shower generated unusual activity and corresponding publicity. I'll always remember those years as the ones in which my two free-thinking daughters — who often show a good-humored disdain for whatever interests me most — chose to become avid meteor-watchers. And indeed, even though there were no storms, few who watched were disappointed. Many around the globe reported seeing rich Perseid displays.

This year doesn't look like a good one for the Perseids, however. For those in the Americas, the peak of the shower occurs on the night of August 12/13. Unfortunately, the Moon is full on August 10 and will still be very bright two nights later. Its light will drown out the fainter Perseids during the best hours for watching meteors, between midnight and dawn.

The Perseids tend to increase gradually in abundance for some nights before their peak, however. To avoid the Moon this year, you might try watching for meteors in the hours before dawn, starting around August 4 or 5. After that, the Moon sets later, edging into your viewing time with each passing day. The last good morning to watch without the Moon is August 8, when you'll have about a two-hour window between moonset and bright morning twilight. You won't see as many meteors as you would have at a moonless peak of the shower, but even a single good one can be memorable. ☐

Deborah Byrd writes and produces the daily "Earth and Sky" radio series. Rick Shaffer is an engineer and writer living in Arizona.

Observer's Challenge:
Pluto's Last Gasp of '95

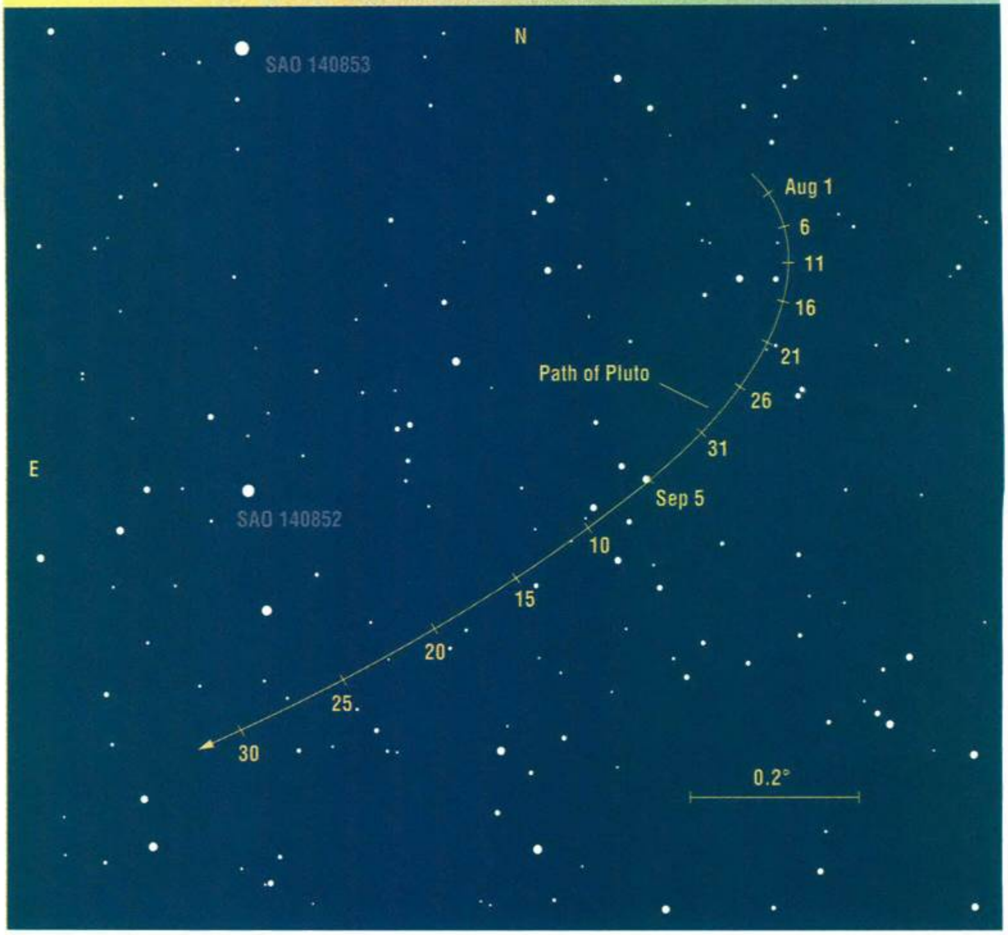
Although Pluto is now well past its May opposition, the observing circumstances have changed little since then. Because the planet lies so far from the Sun, its brightness changes insignificantly over the course of the year. More important to finding it than its brightness is its location in the sky. With Pluto now lying in northeastern Libra, it lies high in the south after sunset and is well-placed for locating.

But that doesn't mean it will be easy. To have a good chance at finding the distant planet, you'll want to use at least an 8-inch scope. A dark observing site, one far removed from the lights of the city, will help, as will having the Moon out of the evening sky. That means the best time for spotting Pluto in August and September will be in the last two weeks of each month.

Using the chart (which shows Pluto's position at 11 p.m. EDT, 10 p.m. CDT, 9 p.m. MDT, and 8 p.m. PDT), center the area where Pluto lies in the field of your lowest power eyepiece. Then increase the power until the level of background light drops below what your eye can detect. If you can't pinpoint Pluto from the chart alone, make a careful drawing of all the stars you see in the field. If the sky is dark and steady, your drawing should reach past the 13.7-magnitude brightness of Pluto. On the next night of good seeing, repeat the process. Comparing the two drawings should reveal the one object that has moved. That's Pluto. — *R.S.*

COORDINATES FOR PLUTO

Date	R.A. (2000)	Dec.
August 1	15h54.6m	–6°28'
August 6	15h54.6m	–6°31'
August 11	15h54.5m	–6°33'
August 16	15h54.6m	–6°36'
August 21	15h54.6m	–6°39'
August 26	15h54.8m	–6°42'
August 31	15h55.0m	–6°45'
September 5	15h55.2m	–6°49'
September 10	15h55.5m	–6°52'
September 15	15h55.8m	–6°56'
September 20	15h56.2m	–7°00'
September 25	15h56.7m	–7°03'
September 30	15h57.2m	–7°07'



FIND A ROCK IN SPACE

Every clear night provides the opportunity to see dozens of asteroids as they move slowly against the starry backdrop.

by Mark J. Coco

Jean-Guy Moreau

ASTEROID 433 EROS SLIDES ACROSS NGC 1647, an open star cluster in Taurus, on February 16, 1982.

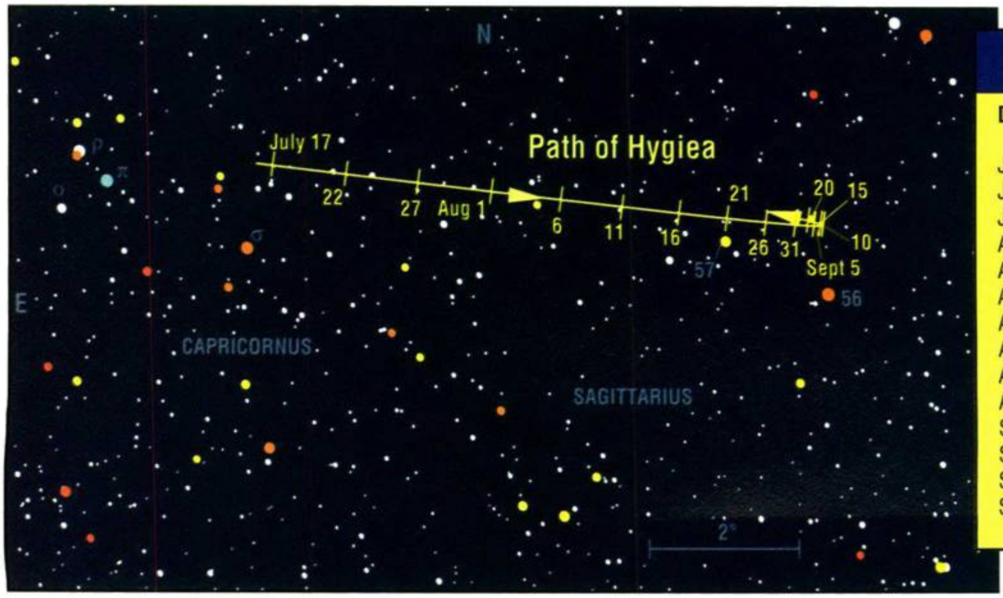
A silent family of rocks in space presents itself to anyone who owns a small telescope. A few of these rocks, or asteroids, are visible even in binoculars. Astronomers know of 6,000 asteroids, though something more than 100,000 may exist. Each slowly tumbles in space and measures from the size of a baseball up to 600 miles across. Most orbit the Sun in the zone between Mars and Jupiter and may be debris from several small planetlike bodies that once inhabited this zone. Others have orbits that carry them close to the Sun or far outside the disk of nine planets.

Asteroids sneak across the sky night after night, moving at different rates and in different directions than the stars that seem to arc overhead as Earth rotates. This article contains maps for six asteroids that are best visible this year from mid-July through late September. They range from easy-to-find to moderately challenging. They are 10 Hygiea (10th magnitude), 41 Daphne (11th mag.), 88 Thisbe (10th mag.), 190 Ismene (14th mag.), 426 Hippo (13th mag.), and 704 Interamnia (10th mag.). The numbers preceding the asteroid names refer to their order of discovery.

In our quest for asteroids, we'll explore how to find and observe these rocks with a small telescope and how to use a telescope to photograph asteroids. We'll also consider your chances of stumbling across a previously undiscovered asteroid.

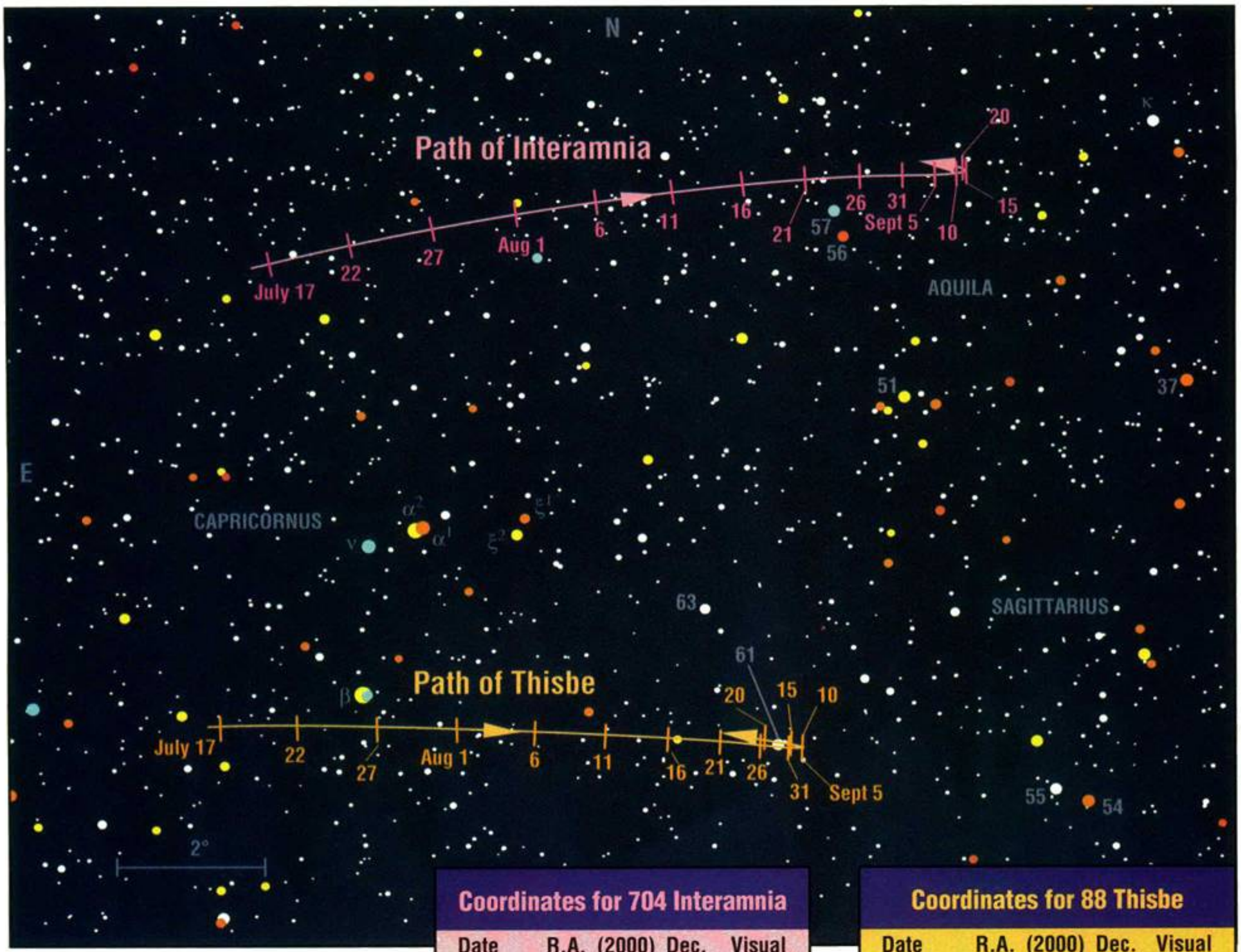
How to See Asteroids

The key to finding an asteroid is knowing exactly where to look. First you need either the asteroid's precise coordinates or a map showing where it will be on the night you observe.



Coordinates for 10 Hygiea

Date	R.A. (2000)	Dec.	Visual Mag.
July 17	20h17.9m	–18°01'	9.5
July 22	20h13.8m	–18°08'	9.3
July 27	20h09.6m	–18°15'	9.4
Aug. 1	20h05.5m	–18°22'	9.5
Aug. 6	20h01.6m	–18°29'	9.6
Aug. 11	19h58.6m	–18°35'	9.8
Aug. 16	19h54.9m	–18°40'	9.9
Aug. 21	19h52.1m	–18°44'	10.0
Aug. 26	19h49.9m	–18°47'	10.1
Aug. 31	19h48.2m	–18°49'	10.2
Sept. 5	19h47.2m	–18°50'	10.3
Sept. 10	19h46.7m	–18°50'	10.4
Sept. 15	19h46.8m	–18°49'	10.5
Sept. 20	19h47.5m	–18°46'	10.6



ASTRONOMY: Steven G. Davis

Coordinates for 704 Interamnia

Date	R.A. (2000)	Dec.	Visual Mag.
July 17	20h26.1m	−8°56'	10.1
July 22	20h21.6m	−8°40'	10.0
July 27	20h17.0m	−8°27'	10.0
Aug. 1	20h12.4m	−8°16'	10.0
Aug. 6	20h07.9m	−8°07'	10.1
Aug. 11	20h03.6m	−8°00'	10.2
Aug. 16	19h59.7m	−7°54'	10.3
Aug. 21	19h56.2m	−7°50'	10.4
Aug. 26	19h53.3m	−7°47'	10.5
Aug. 31	19h50.8m	−7°45'	10.6
Sept. 5	19h49.0m	−7°44'	10.7
Sept.10	19h47.9m	−7°43'	10.8
Sept.15	19h47.3m	−7°42'	10.9
Sept.20	19h47.4m	−7°41'	11.0

Coordinates for 88 Thisbe

Date	R.A. (2000)	Dec.	Visual Mag.
July 17	20h29.0m	−15°13'	9.9
July 22	20h24.7m	−15°13'	9.8
July 27	20h20.3m	−15°14'	9.7
Aug. 1	20h15.8m	−15°17'	9.8
Aug. 6	20h11.6m	−15°19'	9.9
Aug. 11	20h07.3m	−15°22'	10.0
Aug. 16	20h04.1m	−15°25'	10.2
Aug. 21	20h01.2m	−15°28'	10.3
Aug. 26	19h59.0m	−15°30'	10.4
Aug. 31	19h57.4m	−15°31'	10.5
Sept. 5	19h56.6m	−15°32'	10.7
Sept. 10	19h56.6m	−15°31'	10.8
Sept. 15	19h57.3m	−15°29'	10.9
Sept. 20	19h58.7m	−15°26'	11.0

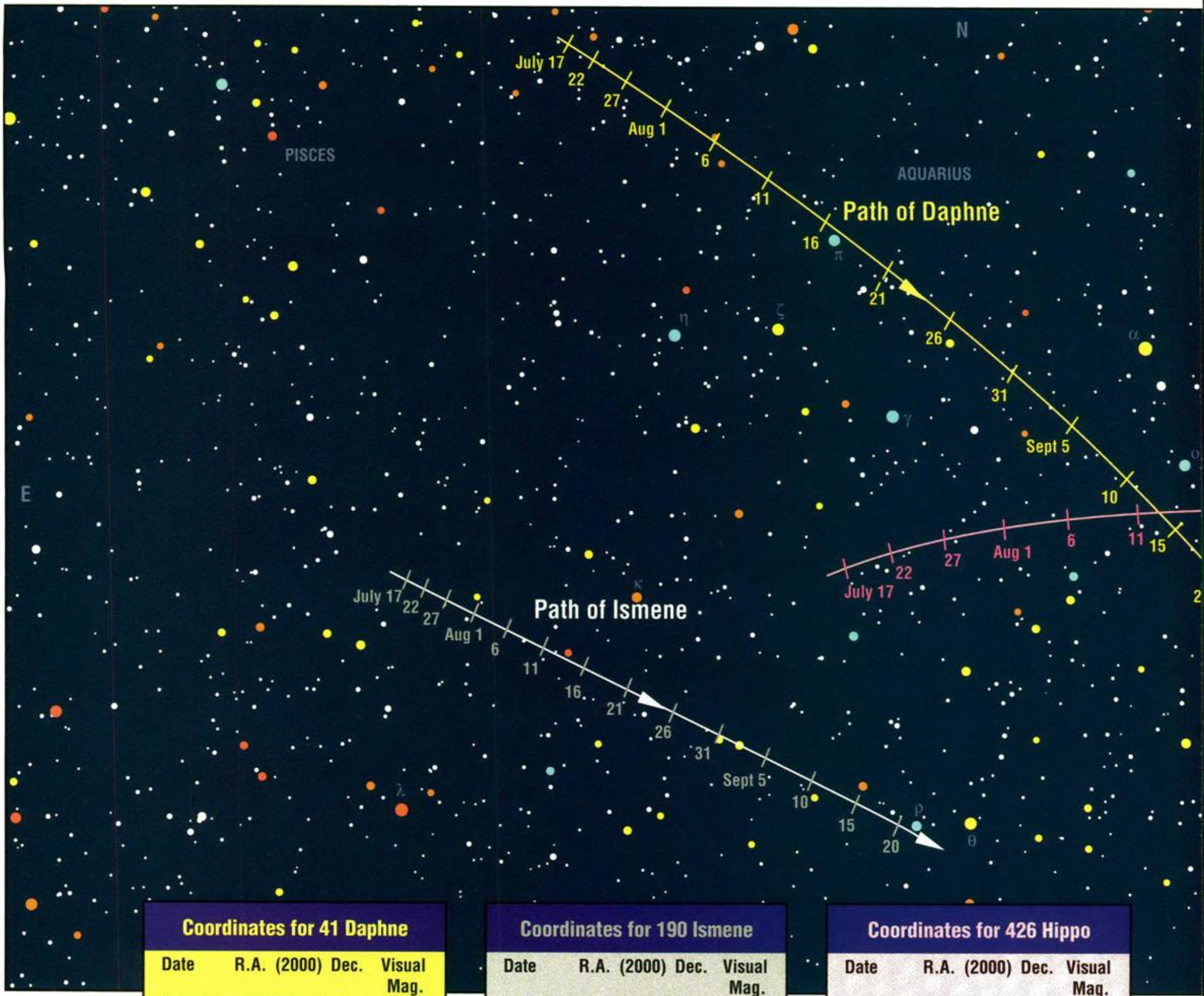
An atlas like Wil Tirion's *Sky Atlas 2000.0* or *Uranometria 2000.0* by Wil Tirion, Barry Rappaport, and George Lovi will permit zeroing in on the correct field. You can either use setting circles or "star hop" to the proper location in the sky (see "See You at the Hop," page 74). Once you're there, the asteroid will look like a relatively faint star. To identify it, you may want to sketch the starfield as accurately as you can. If you are looking for a 7th-magnitude asteroid, sketch stars down to 8th magnitude. Look at the field again a few hours later or the next night. You should notice that one of the "stars" has moved. The one that moved is the asteroid.

If you don't wish to sketch the starfield and you're searching for a relatively bright asteroid, photocopy the relevant page from a detailed atlas like *Uranometria 2000.0.* This atlas shows stars down to about 10th magnitude, so it works for asteroids brighter than 10th magnitude. Once you've found the correct field, you'll spot the asteroid by the fact that it won't be on the page from the star atlas. Mark the asteroid's position on the photocopy with a pencil and return a few hours or a day later to confirm the asteroid's motion. Thereafter, you can follow the asteroid as long as you like.

You may also wish to track down some of the hundreds of bright asteroids not mentioned here. For a start, check out the Sky Almanac section in ASTRONOMY each month. Usually you'll find one asteroid highlighted per issue. Beyond that, the *Minor Planet Bulletin*, published by the Association of Lunar and Planetary Observers, provides information on asteroids at favorable oppositions, research summaries on asteroids, and asteroid news. For more information, send a SASE to Derald D. Nye, 10385 East Observatory Drive, Tucson, AZ 85747. The Minor Planet Center of the International Astronomical Union publishes an extensive list of asteroids visible at any given time. For more information, contact the Minor Planet Circulars, Smithsonian Astrophysical Observatory, 60 Garden Street, Cambridge, MA 02138.

Capturing Asteroids on Film

It's one thing to see the glimmer of light from an asteroid, quite another to image it. You can make a permanent record of an asteroid using either conventional photography or electronic imaging. The easiest way to



ASTRONOMY: Steven G. Davis

Coordinates for 41 Daphne

Date	R.A. (2000)	Dec.	Visual Mag.
July 17	22h42.0m	4°27'	11.7
July 22	22h40.5m	4°12'	11.6
July 27	22h38.4m	3°52'	11.5
Aug. 1	22h35.9m	3°26'	11.4
Aug. 6	22h32.8m	2°55'	11.3
Aug. 11	22h29.5m	2°19'	11.3
Aug. 16	22h25.8m	1°38'	11.2
Aug. 21	22h22.0m	0°54'	11.1
Aug. 26	22h18.1m	0°07'	11.0
Aug. 31	22h14.2m	–0°42'	11.0
Sept. 5	22h10.5m	–1°32'	11.1
Sept. 10	22h07.0m	–2°22'	11.2
Sept. 15	22h03.9m	–3°11'	11.4
Sept. 20	22h01.2m	–3°58'	11.5

Coordinates for 190 Ismene

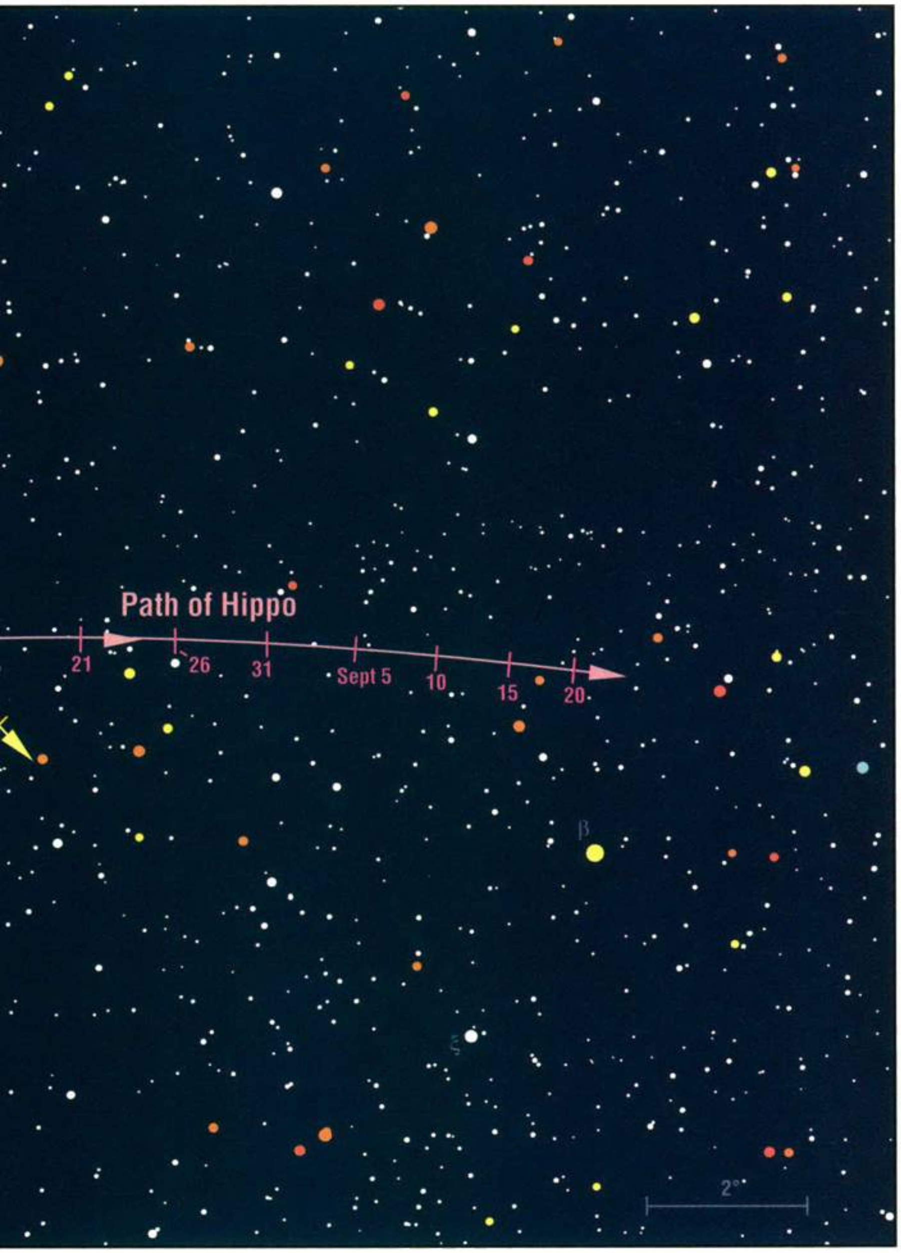
Date	R.A. (2000)	Dec.	Visual Mag.
July 17	22h52.2m	–3°56'	14.1
July 22	22h51.1m	–4°04'	14.0
July 27	22h49.7m	–4°14'	13.9
Aug. 1	22h47.9m	–4°27'	13.8
Aug. 6	22h45.8m	–4°42'	13.7
Aug. 11	22h43.5m	–4°59'	13.7
Aug. 16	22h41.0m	–5°17'	13.6
Aug. 21	22h38.2m	–5°38'	13.5
Aug. 26	22h35.4m	–5°59'	13.4
Aug. 31	22h32.5m	–6°21'	13.3
Sept. 5	22h29.5m	–6°44'	13.3
Sept. 10	22h26.7m	–7°06'	13.4
Sept. 15	22h23.9m	–7°28'	13.5
Sept. 20	22h21.3m	–7°49'	13.6

Coordinates for 426 Hippo

Date	R.A. (2000)	Dec.	Visual Mag.
July 17	22h24.6m	–3°45'	13.5
July 22	22h21.7m	–3°31'	13.4
July 27	22h18.4m	–3°18'	13.3
Aug. 1	22h14.7m	–3°09'	13.2
Aug. 6	22h10.6m	–3°02'	13.1
Aug. 11	22h06.2m	–2°57'	13.0
Aug. 16	22h01.7m	–2°55'	13.0
Aug. 21	21h57.0m	–2°54'	12.9
Aug. 26	21h52.4m	–2°56'	12.9
Aug. 31	21h47.8m	–2°59'	13.0
Sept. 5	21h43.5m	–3°03'	13.1
Sept. 10	21h39.5m	–3°07'	13.2
Sept. 15	21h35.8m	–3°12'	13.3
Sept. 20	21h32.6m	–3°17'	13.4

record a bright asteroid is by using a camera attached to a fixed tripod. Start with a 35mm camera and a normal, 50mm lens set to its widest possible opening. A sturdy tripod will keep the camera stationary. Aim the camera at the starfield. With a cable release, open the shutter for 20 to 30 seconds. To avoid trailed stars on the film, keep the exposures relatively short near the celestial equator compared to the celestial pole. Take a second picture an hour or two later or the following night. The asteroid will have moved, and a careful inspection of the two pieces of film will betray its identity. This camera-and-tripod method works best for asteroids brighter than 10th magnitude.

You can get a closer look at asteroids on film by employing the piggy-



back method. This involves attaching the camera body to a clock-driven telescope so the entire unit tracks the stars. You can use the same short-focal-length lenses as with fixed tripod photography or try some longer-focal-length lenses of 135mm or 200mm. And you can expose film for much longer periods of several minutes or more because the telescope's drive counteracts Earth's rotation. Again, take a second exposure hours or days later to identify the asteroid.

Shooting through the telescope is a more advanced way to record asteroids. But it is significantly more complicated. You can use either a conventional camera and film or an electronic camera called a charge-coupled device (CCD) that captures a digital image. (A CCD camera can be attached to a normal camera lens, also. See "Going Digital with Color," July 1992.) Either way you go, guiding the exposure is tricky, requiring an off-axis guider or a separate guidescope to make minute corrections in the telescope's tracking while the shutter remains open. (See "Beating Back the Guiding Gremlins," September 1994.)

The off-axis guider is a device that employs a small prism; this enables you to simultaneously view and photograph through the telescope. Mounting rings attach the guidescope to the main telescope and allow for independent pointing. This means you can select a guide star outside the field to be photographed. The separate guidescope makes finding a star easier than an off-axis setup does and also makes guiding it simpler.

Whether you use an off-axis guider or a guidescope, consider the final result. If you want a picture showing the background stars as points and the asteroid as a trail passing through them, guide on a star. If you want to "freeze" the asteroid and have the stars appear trailed, guide on the asteroid itself. The choice is yours.

In either case, be sure you have achieved the sharpest possible focus. Out-of-focus images returned from your local photo shop will only disappoint you after all the hard work spent on making the exposures.

Discover Your Own Asteroid

The asteroids you'll observe and photograph are scattered near the ecliptic, the apparent path of the planets across the sky. Many others are also slowly crawling along the ecliptic, and it's possible that you could stumble across one either in your scope's eyepiece or, more likely, on film — when you have plenty of time to examine it. Because the orbits of asteroids can carry them well away from the ecliptic, search within a wide band stretching several degrees away from the ecliptic on both sides.

You may well come across an asteroid unknown to astronomers. So it's a good idea to keep accurate records of the field of view you're observing or photographing relative to known stars on your atlas. Keep track of starting and ending times of the exposures you make. The resulting images can be compared later to see if you have discovered an asteroid.

Another approach to discovering asteroids photographically is to take one long exposure of a starfield and see if anything moves over the exposure time. One problem with this method is that fainter asteroids may go undetected because the asteroid does not remain stationary long enough for the image to build up on film.

Even if you never discover an asteroid of your own, take some time to marvel at the distant rocks already known by astronomers as they glide across the night sky. The brightest asteroids are accessible to binoculars, and even moderately faint asteroids are visible in a 6-inch or 8-inch telescope. You can't lose. Whether you observe asteroids in a telescope's eyepiece or record their light for posterity on film or with a CCD, hunting these bodies will provide hours of satisfaction under the stars. ☐

Mark J. Coco is an experienced observer, photographer, lecturer, and astronomy writer living in Redondo Beach, California.

An Astrophotographer's

GOOFS BLOOPERS

Practical[ly] Jokes!

Astrophotographers have a code of silence — never show off mistakes, much less confess making them. Well, I'm about to break that rule . . .

Story and photos by Alan Dyer

Murphy must have been an astrophotographer, or at least good friends with one. If you've ever set up a telescope and camera under the night sky, you'll know what I mean. If things can go wrong, they will. If not that night, then certainly on some other luckless evening.

But following in the spirit that we learn more from our mistakes than our successes, I present a batch of my greatest "misses" in hopes that others can learn from them as I have.

Blunders in the Dark

Most people approach astrophotography with two overriding concerns: selecting the right film and getting the right exposure. Photographing nighttime targets at first appears so foreign that picking films and exposures seems like a literal shot in the dark. The task is all the more daunting because, unlike in daytime photography, you can't rely on light meters or automatic exposure controls to do the thinking.

Astrophotography's real challenge lies in simply focusing the image. Attach a camera to a telescope, and it's surprising how dim and grainy the image becomes. How can you focus the image when you can't even find the object?

To subdue bloopers caused by focus problems, use a camera that accepts interchangeable focusing screens and equip it with a bright, fine screen designed for high-magnification photography. This may mean buying another camera body just for astrophotography, an expense you might not have counted on. But it's worth it if you want to seriously pursue astrophotography.

ASTRONOMY has covered focusing techniques as well as exposure, film, and camera selection in previous articles (see "Resources and Photofacts," in the back of this magazine). It has also shown the wisdom of owning a telescope stable mount (see "Beating Back the Guiding Gremlins" September 1994). A good mount not only makes guiding easier, but mitigates the sources of outside vibrations, such as slight night breezes.

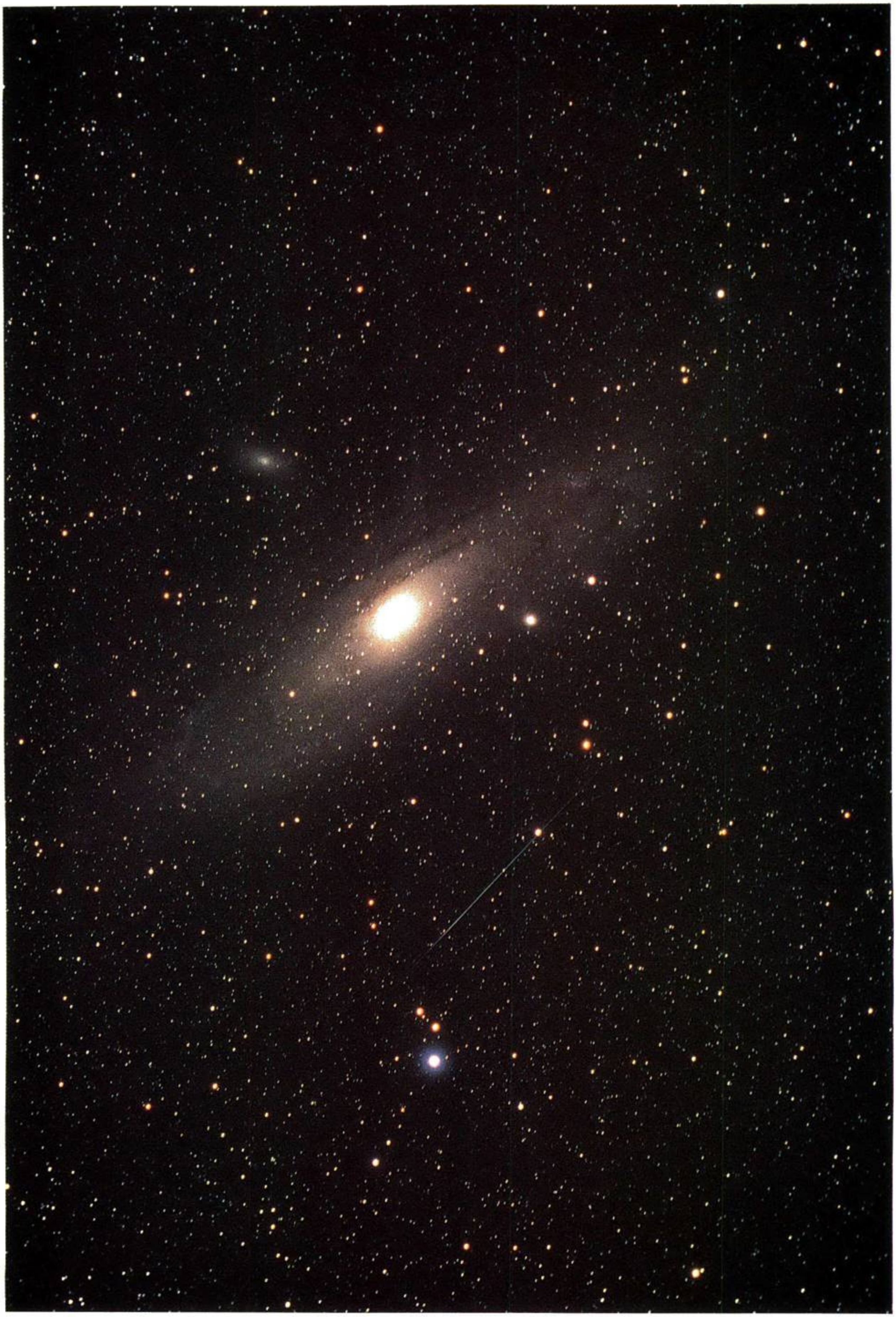
But despite a good mount and the means of landing a sharp focus, bloopers dog even the most experienced of astrophotographers. Let's step back and look at some of these astro out-takes. Many are goofs you'd never think possible when starting out in the hobby, but Murphy is notoriously devious.

Alone Against the Universe?

Accomplished astrophotographers rarely show off their blunders. So when your first rolls come back filled with bloopers, it's easy to think you're the only one making mistakes. But take heart. Even experienced astro-imagers face the challenges that nature and the night sky throw at beginners. There isn't an astrophotographer who hasn't forgotten to take the lens cap off or switch the camera from 1/250-second to Bulb before starting a 30-minute exposure. And everyone has been faced with blurry or trailed images from wind or poor tracking.

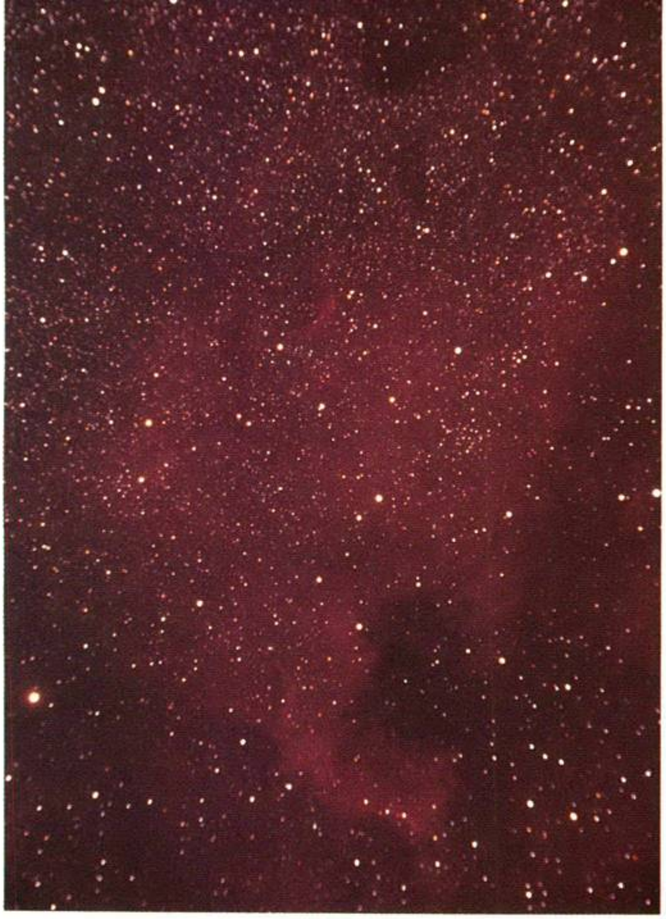
(continued on page 70)

WHAT'S WRONG WITH THIS PHOTO? At least five common defects plague this photo of the Andromeda Galaxy. Can you identify them? Analyzing your own photos with a ruthless eye is an essential first step to better results. To see if you found all of this photo's problems, refer to the end of the article.

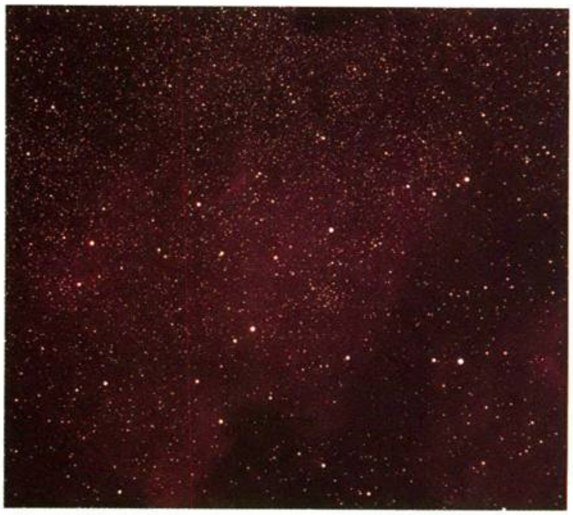


TRIALS OF THE NORTH AMERICA NEBULA

Every astrophotographer has at least one trouble object, one that just doesn't want to be photographed. For me, it was the North America Nebula. Not a tough object — it's big, bright, and easy to find. So why was it so difficult?

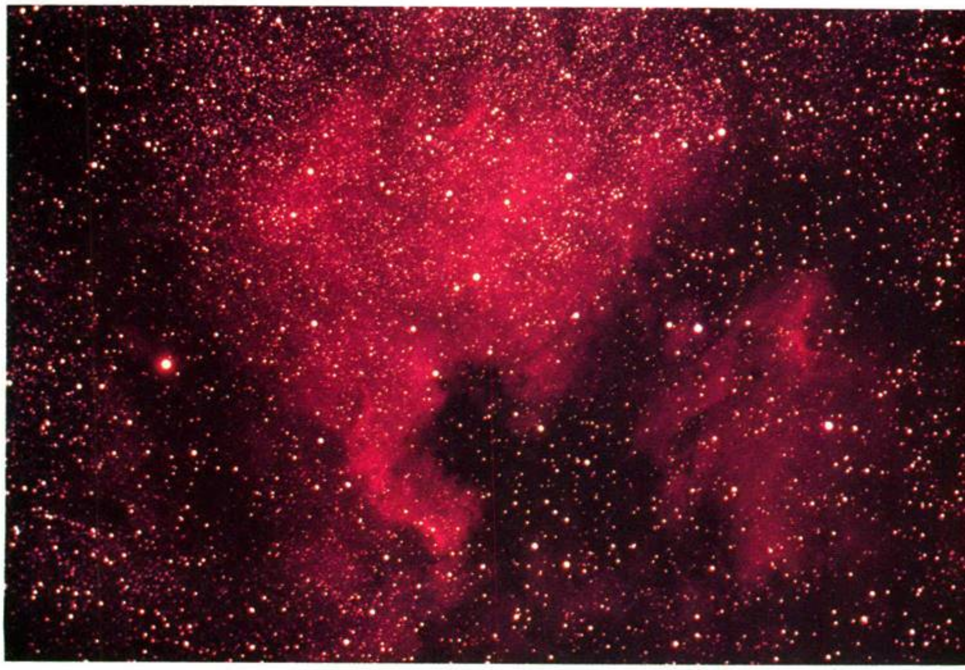


MY FIRST ATTEMPT with a new telescope. Nicely framed, but the stars are all blobs. Bad focus. Oh well, the sky wasn't dark anyway. Next time I'll be more careful to focus precisely on the ground glass. Maybe a brighter focusing screen would help.



GREAT FOCUS, but what's with the framing? Mexico's cut off! Can't have a shot of the North America Nebula without Mexico! Not after NAFTA. Try again.

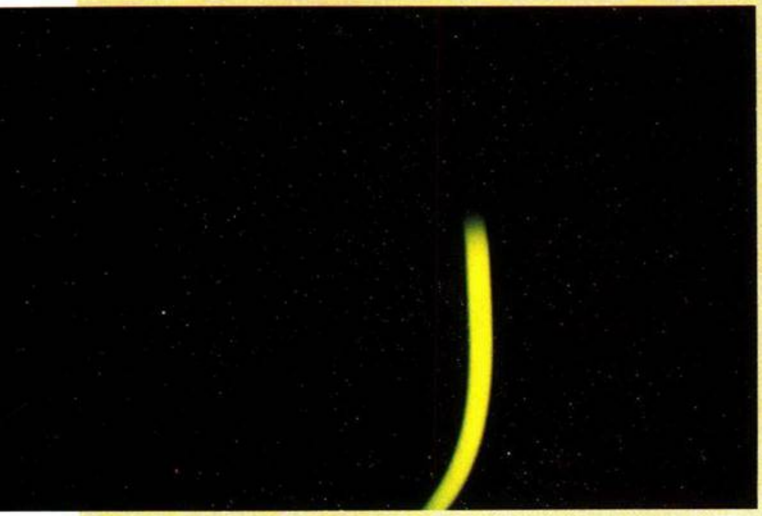
SUCCESS! At last, with all the lessons learned and under the terrific skies of a mountaintop site, the elusive North America finally succumbs. But I wonder how much better it might have been with that new film I've read about? Oh well, there's always next year.



THE CRUEL SKY

Sometimes it seems as if the night takes perverse pleasure in frustrating astrophotographers. The one cloud in the sky covers the very object you're trying to capture. From my location in Canada, bands of aurorae absent all month reappear like clockwork on dark-of-the-Moon weekends. On otherwise great nights, the wind suddenly gusts up from nowhere. To get to Carnegie Hall they say it takes practice, practice, practice. To get good astrophotos, it also takes patience, patience, patience.

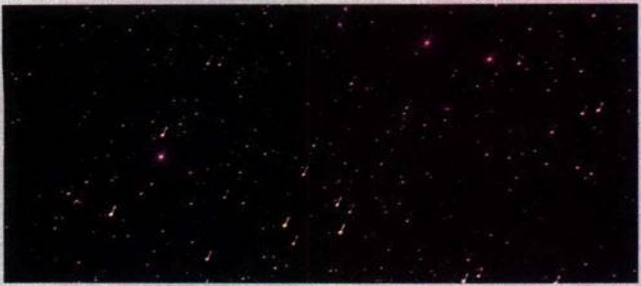
CAPTURING EARTHSHINE on the Moon takes 10- to 60-second exposures. And a calm night. Wind will shake a telescope and blur the image. All high-power shots of the Moon and planets are best left to windless nights with steady seeing conditions. An observatory or sheltered observing site also helps.



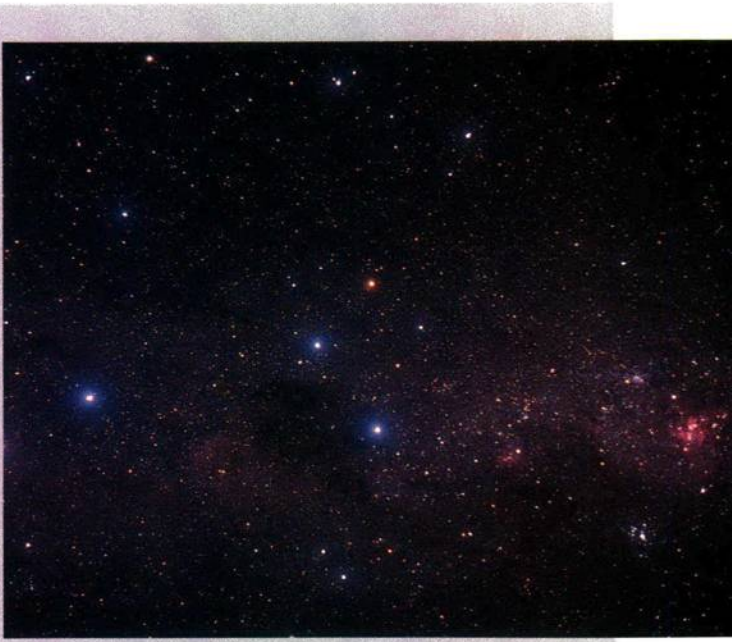
EVERYTHING IS GOING GREAT. There's even the added bonus of lots of meteors dashing across the sky. But wait! Those aren't meteors, they're fireflies. And one just flew right in front of my camera lens. A 30-minute exposure of firefly trails isn't quite what I had in mind.

WIGGLY STARS

Really long exposures through a telescope (5 minutes to over 2 hours) are needed to record faint deep-sky targets. But no telescope can stay precisely aimed on a moving sky target for that long, not without a lot of help. Deep-sky photographers have to guide their telescopes by looking at a nearby guidestar during the exposure while painstakingly tweaking the scope's tracking with slow-motion controls. Sounds straightforward, right? Guess again.



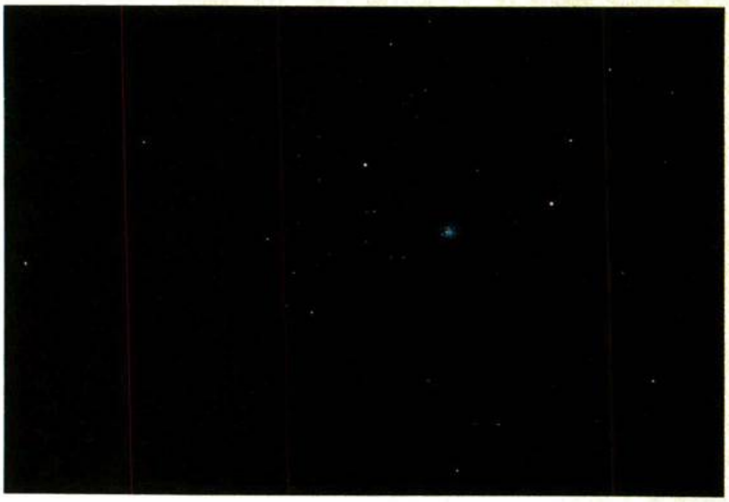
I HAVE NO IDEA WHAT HAPPENED HERE. Nothing seemed to go wrong. Yet all the stars are exclamation points proclaiming my bungled attempt to photograph the Coma-Virgo Galaxy Cluster. Did the guidescope slip out of position? Did the camera accidentally shift? Did the mount settle into the soft ground? Some mistakes are hard to learn from.



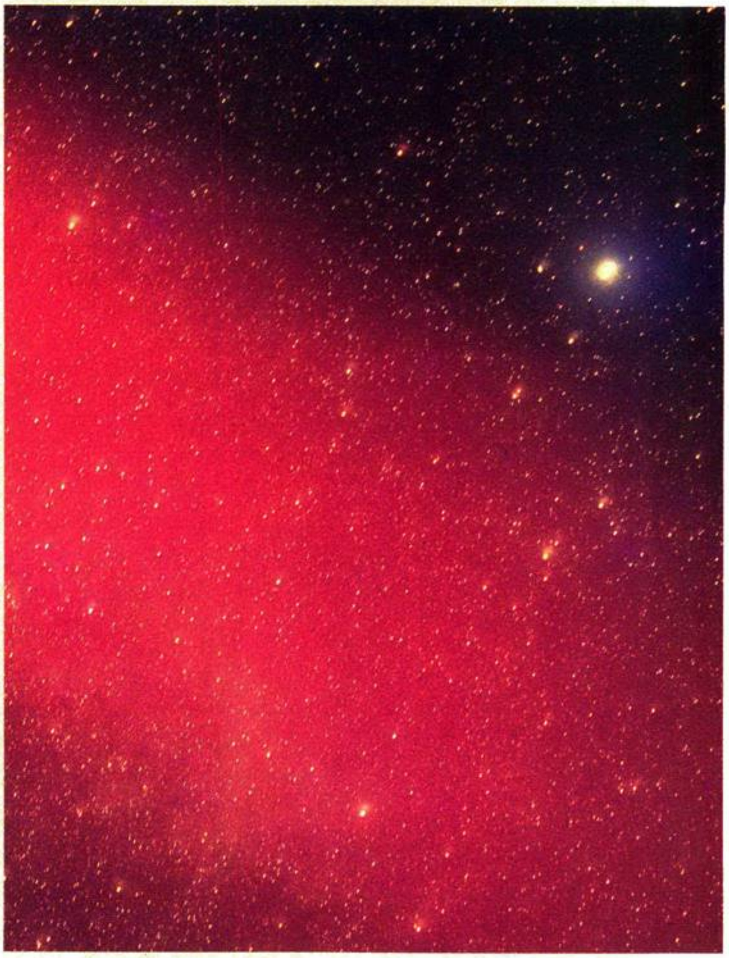
THE DEFINITION OF FRUSTRATION is to go all the way to South America to capture the fantastic southern skies and still be fouled up. Here, I must have accidentally bumped the tripod, producing a sky full of identical binary stars (referred to by those in the trade as "foot binaries.") Fortunately for my sanity, other shots turned out fine.

STUPID PHOTOGRAPHER TRICKS

It would be nice if all my reject photos were caused by forces beyond my control. The truth is, most are the result of "pilot error." It'll happen to you, too. All you can do is figure out what went wrong and make sure it's not done again. There's no sin in making a flub. Not learning from it is the real mistake.



THERE'S NOTHING WORSE than finishing a tedious 60-minute guided exposure, only to find out the shutter was set on ½ second. It's a mistake everyone makes. I learned long ago to always check camera settings and make sure the cable release is set to "lock" before starting long exposures.



BUT IT'S NOT A GOOD IDEA to check the camera settings with a flashlight while the shutter is actually open! This does tend to ruin photos.

Meteorological and mechanical gremlins are always present. Waiting for the right sky conditions, factors that are completely uncontrollable, tries the patience of every backyard astronomer. But it's easy to overcome technical hurdles once and for all if you've purchased the right piece of equipment (a solid mount or a bright focusing screen, for example). After that it simply takes experience. And therein lies the satisfaction of astrophotography. More than most types of photography, capturing the night sky takes a flying-by-the-seat-of-the-pants skill, acquired from making mistakes and learning from them.

So in blatant defiance of all the unwritten laws of amateur astronomy, here are some of my mistakes. And you can see, all kinds of things can go strangely wrong in the night. No one is immune to Murphy's Law. In this field, everyone is always learning, often the hard way. Even when you do perfect a technique, chances are you'll want to move on to try something new, forever seeking that better photo.

And you'll get it, too. For despite all the things that can go wrong, things do occasionally go right in the night. The result will be a photo that makes the effort worthwhile and all the more rewarding. ☐

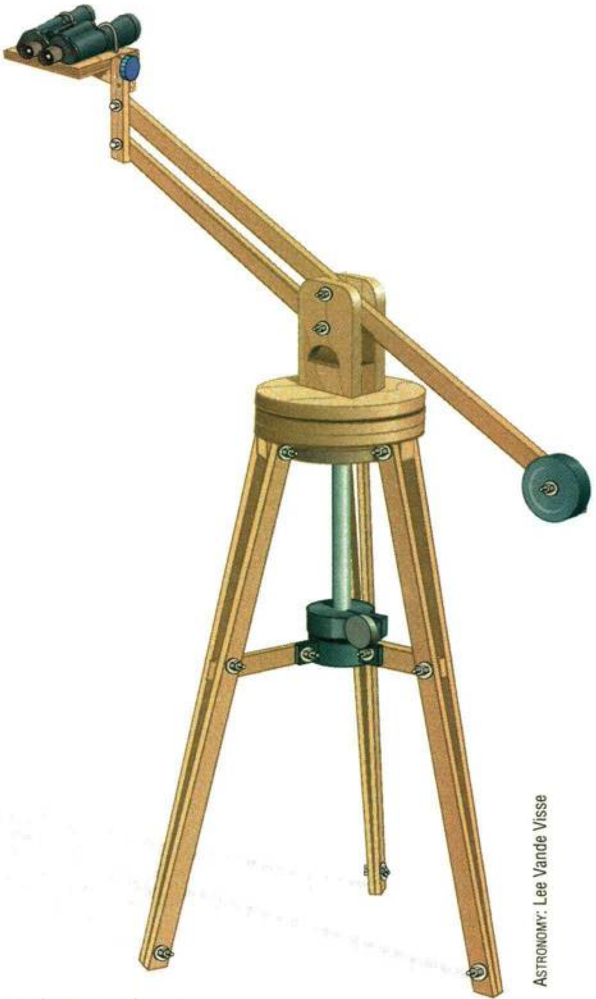
The opening photo of the Andromeda Galaxy on page 67 was marred by five defects: (1) the sky background is not as dark as it should be, (2) the stars are trailed slightly — the autoguider lost track part way through the exposure because of frost on the guidescope lens, (3) frost on the main lens added a blue halo around brighter stars, (4) the focus was off a tad, an effect especially noticeable near the corners of the frame, and (5) a satellite streaked across the picture adding a faint dashed trail. To add insult to injury, a meteor added the short blue streak — but I prefer to call that one a bonus, not a defect!

Alan Dyer, a former editor with Astronomy, *is coauthor with Terence Dickinson of* The Backyard Astronomer's Guide. *And for some strange reason he actually enjoys doing astrophotography.*

Make a Bino Mount

End shaky handheld views with this easy-to-build observing aid.

by David Rogers


ASTRONOMY: Lee Vande Visse

Observing with binoculars is great because you can just grab them and head outdoors. But even low-power binoculars become heavy after a few minutes of observing. And they're almost impossible to hold steady: A starfield dances around the field of view so you can't see fine detail.

What's needed is a sturdy binocular mount that can turn in all directions to permit viewing the entire night sky. A camera tripod can help but it won't permit views directly overhead and requires the talents of a contortionist to get close to the eyepieces when viewing objects high in the sky.

My bino mount provides easy viewing for objects high in the sky, and it holds the binocs away from the tripod so I don't get tangled in the legs. It sits on a 3-foot-high tripod and has a parallel-arm assembly that adjusts the height of the binocs. The mount turns to provide azimuth (side-to-side) motion and the binocular platform supplies altitude (up and down) movement.

Parts to build the bino mount cost less than $20. For another $30 to $40, you'll have the parts for a sturdy tripod (see "Build a Universal Tripod," August 1992). This article concentrates on building just the bino mount.

The Right Height

A person 5'11" tall will want the binoculars at a height of about 67" when looking at the horizon and slightly higher when looking overhead. This bino mount will satisfy observers of that height or shorter. Taller observers shouldn't change the dimensions of the arms but rather mount the arms on a taller tripod, one inch for every inch of height above 5'11".

The parallel arms ride in a fork that in turn rides on the tripod. The fork itself has four pieces: a base, two sides, and a separator. The base is a 10"-diameter circle cut from 3/4" plywood. (Inscribe the circle with a compass and mark this side as the bottom. You'll need the centerpoint later.) The sides are 6" by 10" pieces of 3/4" plywood. The long dimension points up. The top end of each side could be left square, but rounding the corners will prevent injury.

The separator is a 1"-thick piece of wood, 1 1/2" wide and 6" long (cut it from a scrap of 2x4). These are actual dimensions rather than the nominal dimensions given for dried and sawn lumber. The 1" thickness allows for the width of the arm (1" stock, 3/4" actual) and two 1/8"-thick nylon washers that keep the arms from rubbing against the sides.

Glue the separator between the two sides along the bottom edge. Check that the 1" dimension of the block separates the sides, not the 1 1/2" side. Screw the two sides together using two 2 1/4"-long #8 wood screws.

Mark a diameter on the circular base and place a mark 3" from the center on each side. The center of the separator will line up along this line. Place a mark on each end of the separator at its center. Apply glue to the bottom of the fork assembly and place it on the base, aligning the marks on the separator with the line on the base. The 3" marks should help center the assembly. Use two 2"-long #8 wood screws to clamp the forks to the base while the glue dries. Be sure to countersink these screws so their heads are flush with or below the wood's surface.

Find the centerpoint marked on the bottom of the base. Drill a 1/4" hole through the base and separator. This will hold a bolt to attach the base to the tripod. You may wish to cut a 2"-wide hole in each side just above the separator block for easy access to this bolt.

After the glue dries, attach the plastic laminate to the bottom of the base using contact cement. Use a sharp knife to trim the excess laminate. A fine-toothed file can clean up the edge; keep the file at a 45° angle to the base to help prevent future chipping of the laminate.

The laminate base works just like the ones for Dobsonian telescopes. The tripod needs three nylon pads on its top for the laminate to ride on. If the tripod head doesn't have holes for these pads, add them using threaded inserts. A 1/4-20 insert (requires a 5/16" hole) will accept a threaded chair glider that has a nylon end.

Parts for the Bino Mount

Tripod (see "Build a Universal Tripod," August 1992)		
¾" plywood	24" by 24"	
1x3 oak	48" long	
1x2 oak	60" long	
1" by 1½"	6" long	
1¼" diameter	hardwood dowel	
2	#8 wood screws	2¼" long
2	#8 wood screws	2" long
1	#8 wood screw	length same as wood dowel plus ½"
1	¼-20 hex socket screw	1¾" long
2	¼-20 screws	3" long
2	¼-20 screws	2¼" long
5	washers	¼" central hole
6	nylon washers	¼" central hole, roughly 1" diameter
8	¼-20 nuts	
1	1½"-diameter fender washer	
1	knob for hex socket screw	
12" by 12"	plastic laminate	
dumbbell weights, 2 to 3 pounds		
carpenter's glue		
contact cement		
paint or varnish, exterior grade		

Parts for the Binocular Platform

12"	heat-shrink tubing	5/16" diameter
4	#6 wood screws	1¼" long
2	nylon washers	¼" central hole, roughly 1" diameter
2	washers	¼" central hole
2	¼-20 threaded inserts	
2	¼" U-clamps	roughly 2"
2	¼-20 hex socket screws	2¼" long
2	knobs for hex socket screws	

Two Are Better Than One

With the base finished, it's time to tackle the parallel arm assembly. Having only one arm would make the binocular platform tilt as the arm was raised or lowered. Two arms keep the platform level and pointed at an object as you adjust the height.

The assembly is a parallelogram with two arms as the sides, the fork as one end, and a short side arm as the other end. The arms are different lengths: short for the bottom arm and long for the top arm that carries the binocular platform and a counterweight.

The top arm is 1x3 oak and the bottom one is 1x2 oak. Oak will withstand the wear and tear of observing better than pine. First cut the bottom arm to 28" and then round the ends of both arms. Aligning one end of both arms, center the short arm within the width of the broader, top arm and then clamp the pieces together.

Drill a 1/4" hole through both pieces about 1 1/4" from the aligned ends of the arms and a second 1/4" hole through both about 1 1/4" from the other end of the short arm. Drilling the holes with the arms clamped together ensures that the sides of the parallelogram will be equal, a necessity for smooth operation.

The short side arm is a 12" length of 1x2 oak with both ends rounded. Mark a centerline along its length on one of the 1 1/2" sides. Now mark a centerline along the long side of one fork of the base. Align the line on the arm with the line on the base and leave a 3" space between the end of the arm and the bottom of the base. Clamp the arm to the fork.

Drill two 1/4" holes through the arm and one side of the fork (most drill bits aren't long enough to go through the fork in one shot). Drill the first hole about 3/4" from the end of the arm nearest the bottom. Drill the second hole near the top of the fork about 5 1/2" from the first hole. Using a try square, keep the drill bit perpendicular to the fork side as you drill both holes. Unclamp the arm and drill holes through the other fork side using the first set of holes as a guide.

Now We Go Up and Down

The next step is to build the binocular platform. In the end opposite the hole in the side arm, drill a 1/4" hole for one axle for the binocular platform. Instead of going through the 3/4" dimension of the wood, this hole goes through the 1 1/2" dimension about 1" from the end. Drill from both sides of the wood for an accurate hole.

Adjust the binoculars for normal use and lay them on a piece of paper. Trace around the binocs and add at least an inch on both sides. This is the length of the platform, probably around 8 3/4". A good width is about 4 1/2". This keeps the objectives off one end so you can remove dust caps easily. It also keeps the eyepieces off the other end for smooth focusing and prevents you from bumping your nose against the wood.

Cut out the platform from 3/4" plywood and round the corners to prevent painful encounters with them in the dark. Draw a centerline along the long dimension of the platform. At each edge drill a 5/16" hole about 1" deep along this line and screw in 1/4-20 threaded inserts.

Measure the diameter of the objective tubes of the binoculars near where they screw into the fatter prism assembly. Add about 1/4" to this number and buy two 1/4" U-clamps with this inside dimension. It will be around 2". Slide a 6" length of heat-shrink tubing over each clamp and use a hair dryer or heat gun to shrink it.

Set the binocs on the platform and then place the U-clamps over the objective tubes. Angle the clamps for a tight fit and mark the position of each end on the board. Remove the binocs and drill 1/4" holes at these spots.

Two more pieces of wood are needed to complete the mount: the second axle support and the platform crosspiece. The axle support is simply a 3 1/4" length of 1x2 oak. Round one end. About 1" from this end, drill a 1/4" hole through its 1 1/2" dimension for the second axle.

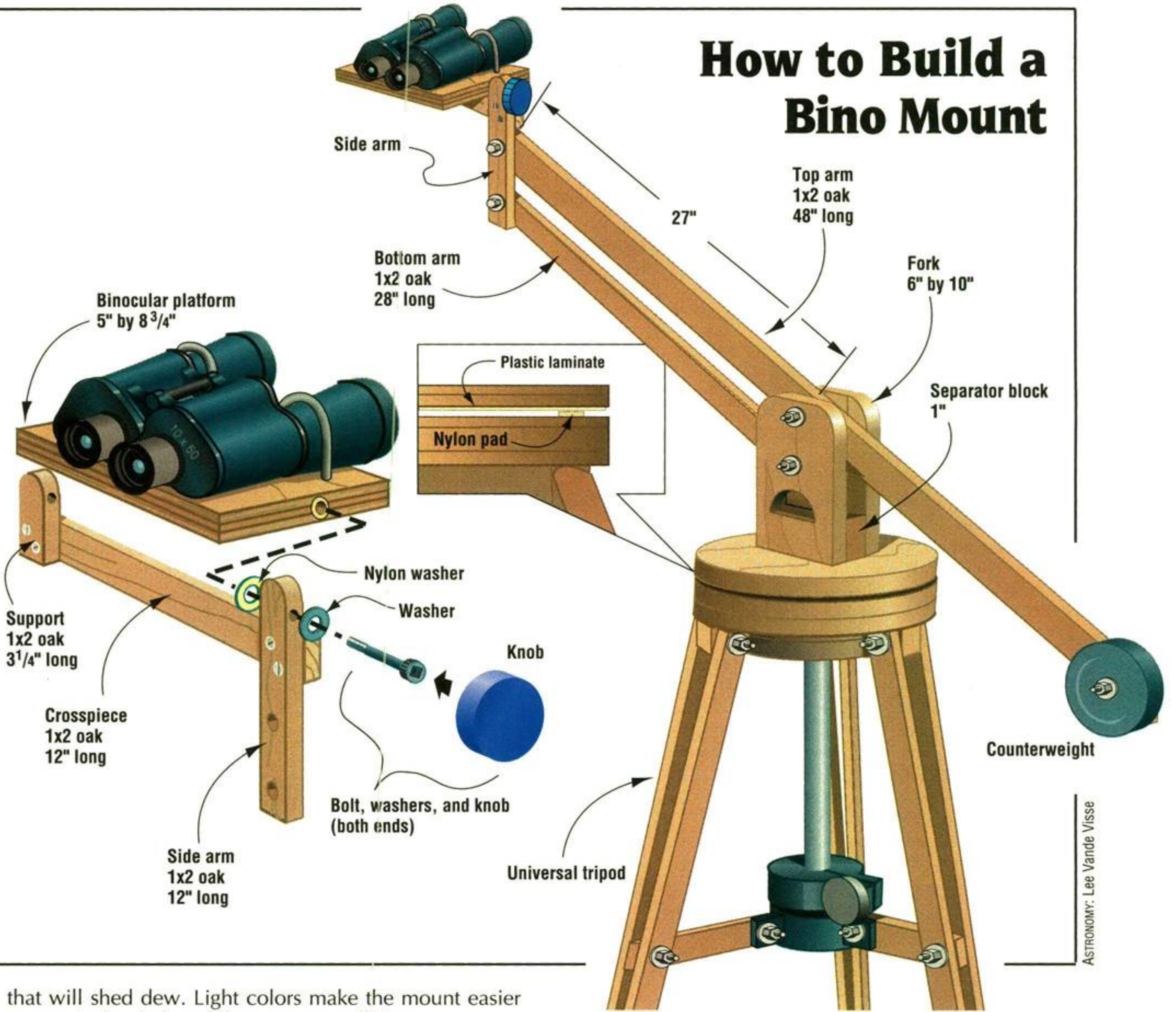
The crosspiece is also 1x2 oak. Its length is equal to 3" plus the thickness of two nylon washers (around 1/4") plus the length of the platform. It will be around 12".

The crosspiece should be on the back side of the short arm as seen by the observer. First mount the crosspiece on the back of the arm. It goes about 2 1/16" from the top of the arm. This should allow just enough room to clear the nuts of the U-clamps. Apply glue to the joint but just clamp it for now. Now glue and clamp the second axle support. Stick a dowel through the two axle holes to line them up. Check that the crosspiece runs parallel to this rod. When everything lines up, screw the joints together using two 1 1/4"-long #6 wood screws on each end. Set the assembly aside to dry.

All Together Now

Before assembling the bino mount, paint or stain and varnish all the parts. Use a good exterior-grade finish

How to Build a Bino Mount


Side arm
Top arm
1x2 oak
48" long
27"
Bottom arm
1x2 oak
28" long
Fork
6" by 10"
Binocular platform
5" by 8 3/4"
Plastic laminate
Nylon pad
Separator block
1"
10 x 50
Nylon washer
Washer
Support
1x2 oak
3 1/4" long
Knob
Crosspiece
1x2 oak
12" long
Counterweight
Bolt, washers, and knob
(both ends)
Side arm
1x2 oak
12" long
Universal tripod

ASTRONOMY: Lee Vande Visse

that will shed dew. Light colors make the mount easier to spot in the dark and thus prevent collisions.

After the finish completely dries, assemble the binocular platform. Attach knobs to two 1/4-20 hex socket screws 2 1/4"-long. Place a nylon washer onto each of the screws and then insert them into the axle holes. Set the platform in place, put a washer between each support and the platform, and thread the screws into the inserts in the platform. Snug the screws to keep the platform from moving.

Next attach the fork to the tripod using a 1 3/4"-long 1/4-20 screw and washer (consider using a hex socket screw with a knob). Don't snug the screw tight because the fork must turn.

Place the top arm in the fork and line up the middle arm hole with the top hole in the fork. Place a washer on a 3"-long 1/4-20 screw, insert the screw through the hole using nylon washers between the fork and the arm, and fasten the screw with a washer and two nuts. First tighten the inboard nut so the arm moves with slight resistance and then tighten the second nut against the first so it won't come undone. Attach the bottom arm to the fork in the same way.

The short arm goes on next. Line up the top hole in the short arm with the hole in the top arm. Put a washer on a 2 1/4"-long 1/4-20 screw, pass it through the hole in the short arm, place a nylon washer on the screw, and pass the screw through the top arm. Secure the screw with a washer and two nuts as for the fork assembly. Attach the short arm to the bottom arm in the same way.

Attach the binocs to the platform using the U-clamps and nuts. Be careful — if you let it go, the extra weight will make the arms drop suddenly.

Clamp a weight to the top arm opposite the binocs and slide it up and down until it balances the binocular platform. Mark this position and remove the weight. Cut the 1 1/4"-diameter dowel to a length equal to the weight's thickness. Screw the dowel to the arm at this spot using a 1 1/4" fender washer to hold the weight on the dowel. Don't glue the dowel: You will want to move the weight to permit using binoculars of different sizes.

Now for the big moment. Carry the bino mount outside and find Sagittarius above the southern horizon. Aim the binoculars at the broad expanse of Milky Way above the constellation. Isn't the steady view wonderful? Now there's nothing left to do but gaze at all those great deep-sky objects in the Milky Way and enjoy binocular observing as never before. ☐

David Rogers enjoys viewing the night sky through his binoculars from central Kentucky.

SEE YOU AT THE

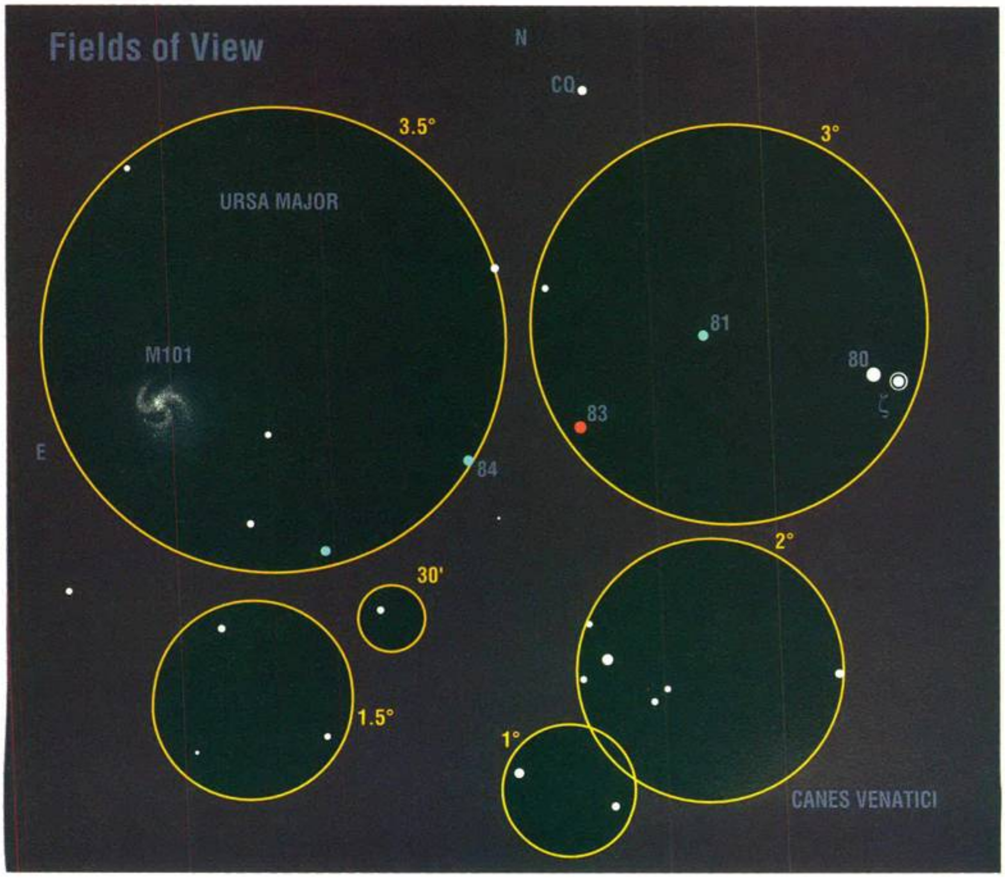
Learn this easy technique and step your way to deep-sky objects anywhere in the sky.

by Robert Garfinkle

Getting there is half the fun, they say. This is certainly true when traveling between the stars in search of star clusters, nebulae, galaxies, and such. Using a technique called star-hopping, you step your way across the heavens until you arrive at your ultimate destination. It's easy, it's fun, and it's a great way to learn the landscape of the night sky.

Star-hopping is like crossing a wide stream on stepping-stones. To get from point A to point B, you step, or hop, from star to star using a finder scope's (or eyepiece's) field of view as a guide. Your hops often lead to a wonderful object while taking you past a multitude of interesting sights along the way.

During this viewing session you'll star-hop to the Whirlpool Galaxy through Ursa Major, encounter double stars and distinctive asterisms in Cygnus and the Milky Way, and then delve into the many deep-sky riches scattered throughout Scorpius and Sagittarius. You'll learn how to measure field of view and how to use that information to plot hops across star atlases.



My, What a Big Field You Have . . .

Before you can star-hop, you need to determine the size of the field of view of your finder or eyepiece, which essentially defines how big of a sky step you can take. As a general rule of thumb, a commercial 6x30 finder has a field of view of 3.5°; an 8x50 is about 5°. Estimate the true field of eyepieces of various focal lengths using the Full Moon (0.5°) or by timing the transit of stars on the celestial equator as they drift across the field. Roughly, if it takes one minute for a star to transit, the field of view is .25°; two minutes, 0.5°; three minutes, 0.75°; four minutes, 1°.

This time of year, one of the handiest regions for gauging a large field of view surrounds Mizar and Alcor, a close pair of blue-white stars in Ursa Major that mark the kink in the Big Dipper's handle. At magnitude 2.3, Mizar (Zeta Ursae Majoris) is the brighter of the two stars; fourth-magnitude Alcor (80 UMa) lies 11.8' northeast of Mizar.

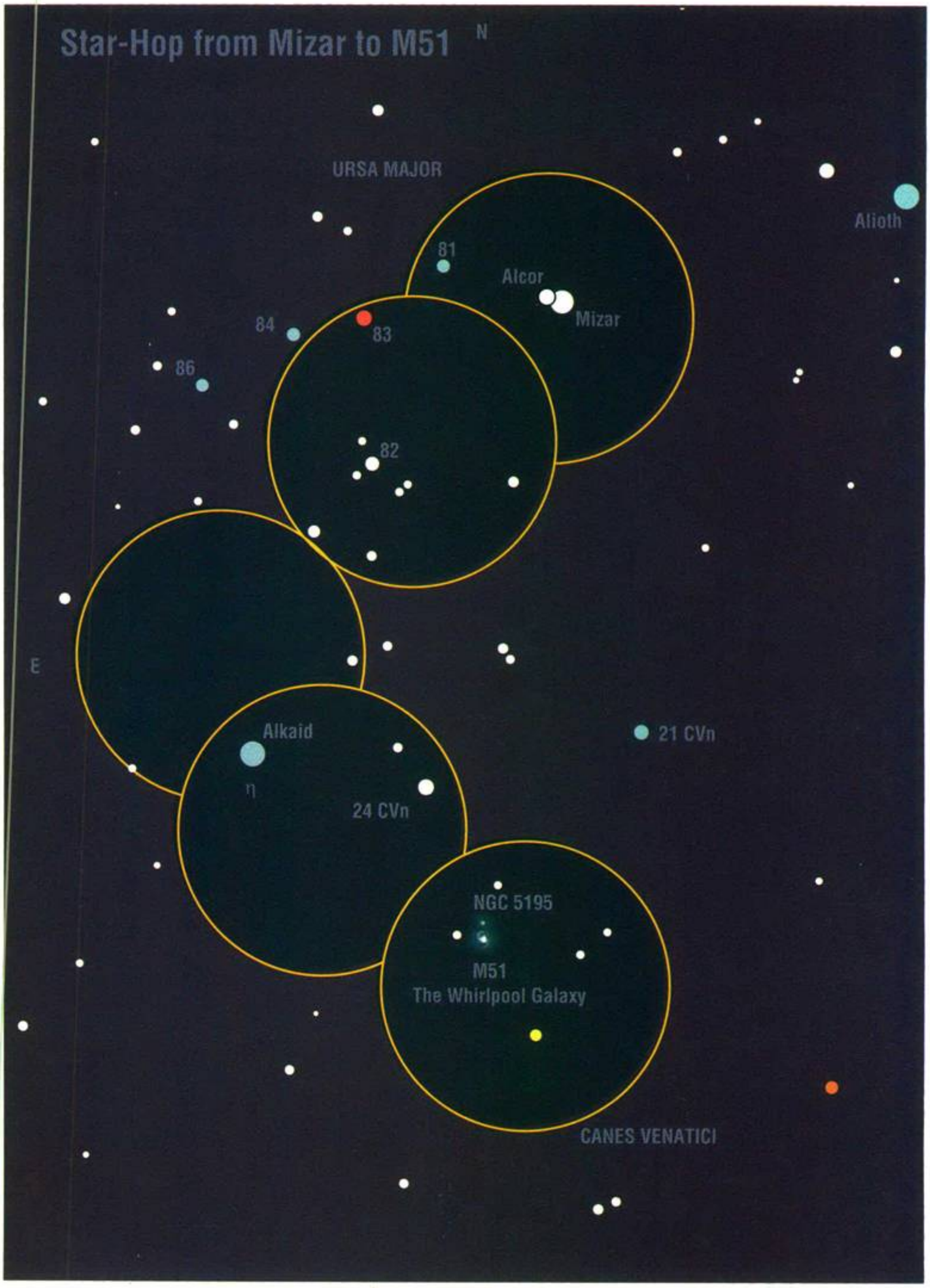
Place Mizar at the 6 or 12 o'clock position in your field of view with Alcor oriented toward the center. A line of three 5th-magnitude stars cuts diagonally across the field east of Mizar. These stars are designated 81, 83, and 84 UMa. The stars 81 and 84 UMa are bluish-white and 83 UMa is strikingly ruddy. South of 83 UMa, look for a group of stars around 82 UMa. Keeping Mizar at the edge of your field, gently move your scope to place 82 and (if your field is large enough) 84 along another edge of the field. The distance between Mizar and 81 UMa is about 1½°, Mizar and 83 UMa 2½°, and Mizar and 84 UMa, 3⅓°.

Now scale down your true field of view to that of a favorite star atlas. Cut a hole from a sheet of clear plastic that approximates the field of view or use a translucent template that has a variety of diameters up to about three inches. Hops around the chart will then correspond directly with hops in the sky.

Star-Hop #1: The Whirlpool Galaxy

Let's begin by hopping to the Whirlpool Galaxy (M51) via Mizar and Alcor. (Refer to the map on page 75.) Using an eyepiece with about a half-degree true field of view, place the pair near the southern edge of the field. As mentioned, Mizar is the brighter star. If this is the first time you have looked at Alcor and Mizar through a telescope, you may think

HOP



Mizar B is Alcor, but Alcor should be near the center of the field. The faint star near and southeast of Alcor is Sidus Ludovicianum (so-named in 1723 by followers of Ludwig V who mistakenly believed the star was a planet or undiscovered star).

The next link is the bright star Alkaid (Eta Ursae Majoris), the last star in the handle of the Big Dipper. Use an atlas template to determine how many hops are needed to reach Alkaid. Use the string of stars between Mizar and Alkaid as a guide to Alkaid. (Or simply begin with Alkaid!) Place Alkaid on the northeastern edge of your field then move another hop, past 24 Canum Venaticorum, to the galaxy. Don't be surprised to see only faint light from the Whirlpool. In an 8-inch telescope, you might be able to make out some spiral structure using averted vision, depending on the darkness and clarity of the sky.

Star-Hop #2:
Cygnus, Vulpecula, and Sagitta

The second star-hop involves tracking down several objects in the Cygnus-Vulpecula-Sagitta area (see the map on the next page). These targets are high overhead on summer evenings. Start in Cygnus the Swan at probably the most famous colorful double star, Albireo (Beta Cygni). The yellow and blue stars that comprise this pair are a fine sight in any telescope.

Heading south from Albireo, cross into the constellation Vulpecula the Fox. About 3½° from Albireo you'll encounter the loose open cluster Stock 1. The forty members of this 5th-magnitude cluster appear as a slightly tighter and brighter group within the rich star field they inhabit. South of Stock 1 is a double star consisting of 4th-magnitude Alpha Vulpeculae and 6th-magnitude 8 Vul. About two hops southwest of 8 Vul lies the open cluster Collinder 399. Also called the Coat Hanger, this smattering of stars holds six luminaries in a slightly curving line similar to the arm of this common household item. The bottom of the hook is marked with the 5th-magnitude multiple star 4 Vul. After viewing the cluster at low power in the scope, try to spot it with your eyes.

The next stop is Sagitta the Arrow. Here, you'll find countless Milky Way stars and asterisms. The 4th-magnitude double star Alpha Sagittae and 4th-magnitude Beta Sge form the base of the arrowhead. The middle of the arrow holds the 4th-magnitude ruddy star Delta Sge. Use the alignment of Alpha, Delta, and 6th-magnitude 9 Sge to point you to the globular cluster M71 (NGC 6838), visible in the same finder field. Glowing at magnitude 8.3, M71 appears as a knot of stars without the tightly packed core typical of globulars. A small scope shows this unusually loose structure. The cluster resembles an arrowhead pointing toward 9 Sge. The reddish star Gamma Sge marks the tip of the arrow.

It's a short hop from Gamma Sge to one of the brightest planetary nebulae in the sky, the Dumbbell Nebula (M27). (A planetary nebula is the gaseous shell expelled by a dying star.) Move 3° north from Gamma Sge. The Dumbbell appears as a 7th-magnitude oval smudge in small scopes and binoculars. Scopes 8 inches and larger reveal the Dumbbell's unique shape and its "ears" of very faint nebulosity fanning outward from the core.

Star-Hop #3:
Scorpius and Sagittarius

The grand finale star-hop carries you through the riches of the Scorpius and Sagittarius Milky Way. This area marks the direction of the center of the Galaxy, and looking toward it will reveal the densest region of stars, star clusters, and nebulae in the sky.

Start at the stinger of Scorpius, marked by the double star Shaula (Lambda Scorpii) and Lesath (Upsilon Sco). (See the map on the opposite page.) Lesath and Shaula point northeast toward the open cluster M7 (NGC 6475). This cluster has been known since ancient times, as evidenced by references in the *Almagest*, by the Alexandrian-Greek astronomer, Ptolemy. French astronomer Charles Messier noted this object on May 23, 1764. It is the southernmost of the objects included in his catalog of nebulae and star clusters. M7 consists of 80 stars brighter than 10th magnitude, the brightest of which shine at 3rd magnitude. With a large telescope you may spot several double stars in the cluster.

Using your finder again, hop 3½° northwest of M7 and locate the open cluster M6 (NGC 6405). The spread of the brighter stars gives the cluster the appearance of a butterfly's wings, hence its name, the Butterfly Cluster. This 100 million-year-old cluster glows with the light of a single 4th-magnitude star. Its brightest individual stars glow at 6th magnitude.

To continue the hop, leave Scorpius and scan eastward into Sagittarius the Archer. The eight-brightest stars in Sagittarius form a teapot outline, which are easy to see with the unaided eye. At the tip of the spout is the 3rd-magnitude yellowish star Alnasl (Gamma Sagittarii). A low-power view north of this star reveals a thick mass of stars known as the Large Sagittarius Star Cloud. Its whitish glow resembles steam from the teapot's spout. Note the foreground dust lanes that appear to divide this cloud into many smaller clouds of stars.

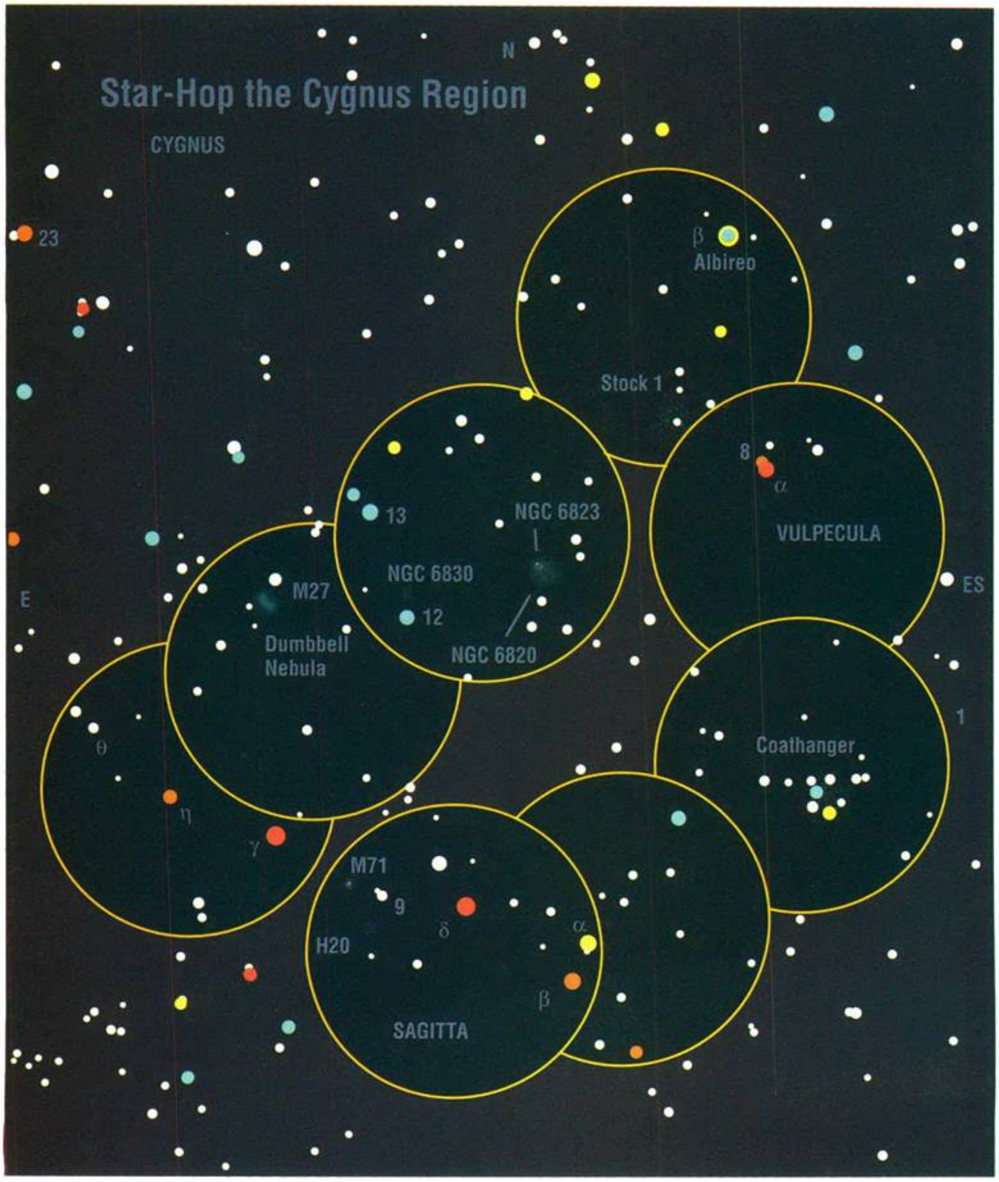
About one hop east of Alnasl lies the middle of the archer's bow, marked by the orange-yellow, 3rd-magnitude star Kaus Media (Delta Sgr). Hop to the top of the teapot to find 3rd-magnitude Kaus Borealis (Lambda Sagittarii). Kaus Borealis also marks the northern tip of the Archer's bow. The finder field of view contains the bright globular cluster M28 (NGC 6626). This cluster shines at magnitude 7.0. Many stars lie scattered around its dense, bright core. Taking one hop northeast of M28 brings you to the more spectacular globular cluster M22 (NGC 6656). This is one of the nearest globular clusters to us, which accounts for its great brightness and large size. The cluster appears as if someone spattered white paint on a black wall. Thousands of faint stars surround the bright core.

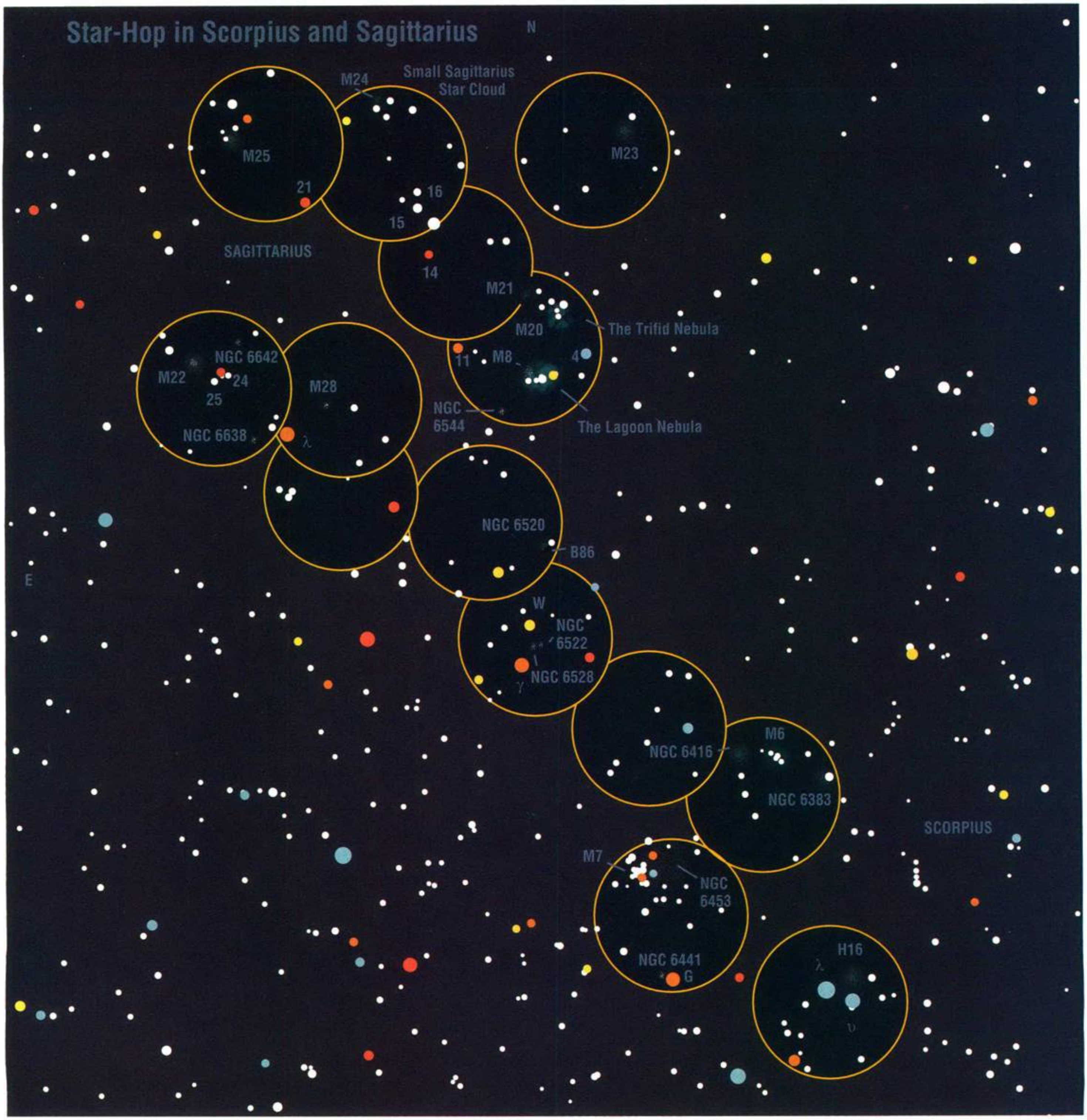
Continuing the hop brings you to the loveliest deep-sky object in the area, the Lagoon Nebula (M8). A large cloud of wispy ionized gas, the Lagoon is a star factory bisected by a dark "lagoon" of dust.

In the immediate area you'll encounter 6th-magnitude 9 Sgr, the open cluster NGC 6530, swaths of glowing gas, and three dark nebulae, B88, B89, and B296. Radiation from 9 Sgr helps power the cloud of gas, creating its soft glow. NGC 6530 is a young cluster, some two million years old. Use a wide-field eyepiece to view this splendid object. A nebula filter helps bring out the wispy nature of the region.

Just north of the Lagoon in the same field, you'll find the Trifid Nebula (M20). The Trifid consists of emission and reflection nebulosity, crisscrossed by veins of dark nebulae collectively called B85. The multiple star HN 40 stands out near the center of the nebula. The loose group of stars you'll see is the 6th-magnitude open cluster NGC 6514, whose stars are forming from the gas cloud. The same low-power field contains the open cluster M21 (NGC 6531). This cluster consists of 70 members whose combined light shines at 6th magnitude. The brightest members are 8th- and 9th-magnitude stars.

Hopping northeast of M21 you'll see a large and dense congregation of stars. This is M24, the Small Sagit-




Star-Hop in Scorpius and Sagittarius
N
M24
Small Sagittarius Star Cloud
M25
21
16
15
M23
SAGITTARIUS
14
M21
M20
The Trifid Nebula
NGC 6642
M22
24
25
M28
11
M8
4
NGC 6544
NGC 6638
λ
The Lagoon Nebula
E
NGC 6520
B86
W
NGC 6522
NGC 6528
γ
NGC 6416
M6
NGC 6383
SCORPIUS
M7
NGC 6453
NGC 6441
G
H16
λ
υ

tarius Star Cloud. The 100-plus members of this rich cluster are difficult to differentiate from the rich background of faint stars, although a wide-field view, like the one you get with binoculars, helps. The two blank areas on M24's northwestern edge are the dark nebulae B93 and B94. Sweep 4° east from the southern end of M24 to observe the large open cluster M23 (NGC 6494). About 150 stars make up this cluster, the brightest of which glow at 9th magnitude.

Our final target is the open cluster M25 (IC 4725). Sweep about 2½ hops east of M23 until M25 appears in your view. Note a group of four bright stars near the cluster's center. The variable star U Sgr is the northeasternmost of these stars. This star's magnitude ranges from 6.3 to 7.1 over a period of 6¾ days.

After traveling through the stellar riches of Sagittarius and Cygnus, try hopping through other regions of the night sky, no matter how challenging. Before long, you may become more familiar with the treasures between the stars than you ever thought possible. ☐

Robert Garfinkle works as a technical writer at Westinghouse Electric Corporation. His book Star-Hopping: Your Visa to Viewing the Universe *was published by Cambridge University Press in 1994.*

ASTRONOMY'S MARKETPLACE

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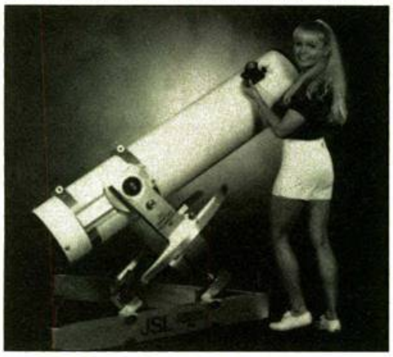

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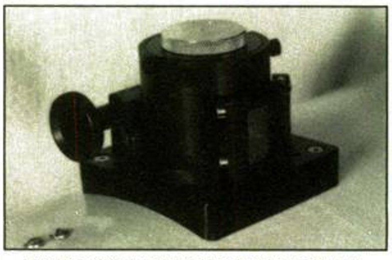

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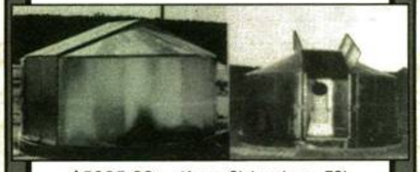

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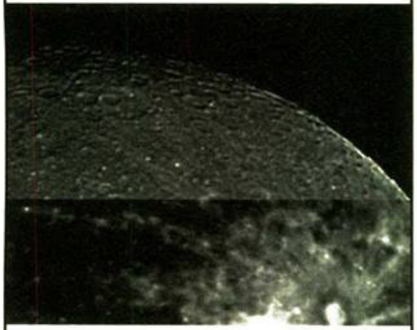

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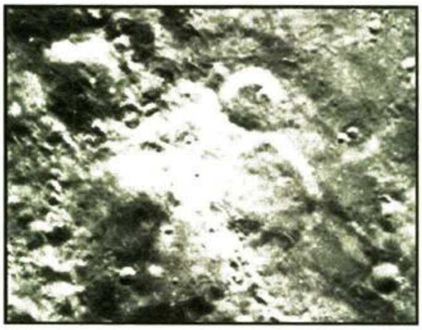
Clementine visited the Moon from February through April 1994 and took almost 2 million images (see "The Moon Comes into Focus," September 1994). These images are now available from the National Space Science Data Center as a set of 88 CD-ROMs. Intended for researchers, the images are raw, meaning that they have not been calibrated or processed. Yet Moon aficionados will want to obtain at least a few of the CD-ROMs to explore the wealth of detail.



Clementine CD-ROMs contain detailed images of the Moon

Images include those taken by the high-resolution camera, the near-infrared camera, the long-wavelength infrared camera, and the ultraviolet-visible light camera. In addition, the UV/VIS camera took images through several filters (for example, in blue light). Comparing images taken at different wavelengths enables scientists to investigate the chemistry of the Moon's surface.The CD-ROMs store these images in a well-organized manner: first sorted by the orbit number during which the frame was taken, next by camera, then by 10° latitude grid, and finally by the order in which the images were taken.

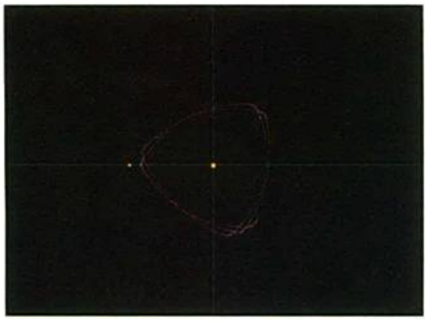
One software tool provided with the CD-ROMs enables users to decompress the PDS data files into TIFF, GIF, PDS, or raw image file formats. A second program enables users without image-processing software to view the image.

If you're an avid Moon observer, you'll enjoy hunting through these volumes to find your favorite regions. The filtered images and the perspective afforded by Clementine's orbit around the Moon provide a new window on a familiar object.

Astrophysics with a PC
by Paul Hellings, (Willmann-Bell, Inc., 1994), ISBN 0-943396-43-3, 260 pages, softcover, $19.95. Optional software is available to purchasers of the book from Willmann-Bell, Inc., P.O. Box 35025, Richmond, VA 23235, (804) 320-7016, for $19.95; specify QuickBasic 4.5 or Turbo Pascal 6.0. Minimum requirements are an IBM PC-compatible computer and a CGA display.

Planetarium-type programs limit astronomers' views of objects to bright dots and fuzzy patches spread across a sky map. *Astrophysics with a PC* lets armchair astronomers see inside objects and explore the nature of stars and galaxies. It has 13 chapters that explain 12 astrophysical models and their corresponding computer programs.

The models and programs let users examine the changing orbit of an asteroid, the inside of a white dwarf, the structure of cometary tails, star formation in galaxies, the



Watch the orbit of asteroid 153 Hilda change with time

expansion of the universe, the brightness of a meteor as it plunges to the ground, and other topics.

Warning! This book utilizes quite a bit of math, including simple calculus. One could run the programs without looking at the math, but at least a cursory knowledge of what the variables represent is needed to properly input starting values and to understand the results of the programs.

The book lists instruction codes for the 12 programs written in Microsoft QuickBasic 4.5. Rather than type in all the programs and make the inevitable mistakes that will frustrate all attempts at running the program, buy the companion diskette containing the programs. Unlike most software products that give you only the compiled programs, this disk also contains the program source code which lets the user experiment with initial values, examine how the calculations are made, and enhance the display. (Remember that the programs are copyrighted so users are not free to distribute the programs with or without any user-made changes.)

The programs won't wow users with fancy graphics and sophisticated animations. But they will enable astronomers to explore several phenomena in detail rather than just read about how others do it.

New Frontiers Screen Savers

Ocean State Publishing Corp., P.O. Box 747, Woonsocket, RI 02895-0784, (401) 767-3376. Price: $24.95. Minimum requirements: 80386-based computer, 4 MB of memory, Windows 3.1 (Windows 95 compatible), 1 MB of free space on a hard drive, a CD-ROM drive, and a VGA monitor.

Tired of flying Windows and warping through space? *New Frontiers Screen Savers* will give your PC an astronomical look. More than 400 full-color images from NASA grace this collection, allowing users to change the image daily or to find an image they never tire of. The CD-ROM includes Image Carousel screen saver software to display the images. Users can capture the images for use in desktop publishing programs or use them as the wallpaper behind applications in Windows.

CD-ROMs

Voyage through the Solar System

Palo/Haklar, 650 North Bronson Street, Suite 144, Hollywood, CA 90004, (213) 461-0982. Price: $49.95. Minimum requirements are either a Mac with 5 MB of memory, a CD-ROM drive, and a color monitor or an 80386-based PC with a sound card, a Super VGA display, a CD-ROM drive, and Windows 3.1.

This CD-ROM contains an interactive tour of the solar system that lets users explore all the planets, planetary satellites, asteroids, and the Sun. Clicking on a planet in the program's map of the solar system brings up a tutorial about the object or one of almost 70 narrated video clips from NASA's Jet Propulsion Laboratory. Clicking on the spacecraft traveling through space starts a video that explains current ideas about how the planets formed. The disk includes a 17-page glossary that explains some of the terms used in the tour.

Welcome to the Planets CD-ROM

NASA Planetary Data System, available from the National Space Science Data Center, Code 633.4, Goddard Space Flight Center, Greenbelt, MD 20771, (301) 286-6695, fax (301) 286-4952, e-mail request@nssdca.gfsc.nasa.gov. Price: $36 ($6 for additional copies in the same order). Will run on Macs using the included software or on any computer that has the Mosaic program.

Twenty-five years of planetary exploration has resulted in zillions of images. NASA has collected 190 of the best spacecraft shots of all nine planets, the Moon, comets, asteroids, and the satellites of the planets. The CD-ROM's Mac software or *Mosaic* (the World-Wide-Web-browser) will display these images along with accompanying text in an interactive fashion. Teachers may wish to use the disk to provide an overview of planetary exploration or use portions of the disk for specific exercises. Computer users with a GIF-image viewer can also display the images. ☐

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Mr. Barnard's Universe

The Immortal Fire Within: The Life and Work of Edward Emerson Barnard

William Sheehan, (Cambridge University Press, 1995), ISBN 0-521-44489-6, 418+ pages, hardcover, $49.95.

For those well-versed in the history of astronomy, Edward Emerson Barnard is known for much more than the nearby star that bears his name. He was an exceptional observer, as evidenced by his 1892 discovery of Jupiter's diminutive inner satellite Amalthea — the last moon to be discovered visually. Barnard is renowned for his pioneering wide-field, deep-sky photography. His Milky Way plates revealed all sorts of new objects and helped astronomers realize that dark nebulae were clouds of opaque matter. An astronomer with such noteworthy accomplishments deserves a lengthy biography, so science writer and amateur astronomer William Sheehan's volume, the first extended biography of Barnard, is long overdue.

Barnard at Yerkes/Vanderbilt Observatory

Sheehan devotes the first chapters to Barnard's upbringing in Nashville, Tennessee. Even though Barnard never accumulated vast sums of wealth, he was the quintessential Horatio Alger rags-to-riches hero. Born fatherless into destitute poverty in 1857, Barnard was a studio photographer who taught himself astronomy. In 1887 he graduated from Vanderbilt University without a degree.

Through perseverance, dedication, and strength of character, Barnard became one of the world's foremost astronomers. Barnard was legendary for observing from dusk to dawn, and he would never allow a clear evening to go to waste. (When entertaining dinner guests, he would often excuse himself if skies were clear and dark.) Even while suffering from the debilitating effects of diabetes during his later years at Yerkes Observatory, a frigid Wisconsin winter night would never deter Barnard.

Barnard hunted comets in his pre-professional days. His discovery of eight comets between 1881 and 1887 established his reputation and helped him land a position at the newly commissioned Lick Observatory in 1888.

Milky Way in Taurus/Yerkes Observatory

Barnard's years at Lick were both productive and tumultuous. He discovered Amalthea and began his ground-breaking photography. But Sheehan also chronicles Barnard's stormy relationship with observatory director Edward Holden. The less-capable Holden wouldn't allow the junior Barnard to use the facility's largest telescope, the 36-inch refractor, on a regular basis. It was only after Barnard achieved worldwide notoriety for his discovery of Amalthea that Holden, under pressure from Lick's regents, begrudgingly permitted Barnard access to the 36-inch one night per week.

The latter third of the book details Barnard's career at Yerkes. Even though Barnard stopped looking for new comets, he retained his fascination with these transient objects. Until his death in 1923, he photographed every comet visible in Yerkes' sky. Barnard took a keen interest in comets with peculiar tails. In 1909 he proposed that changes in comet tails might be due to the same solar disturbances that spawn aurorae and magnetic storms; an idea that was largely forgotten for 60 years but would later prove to be essentially correct.

For readers who wish to explore Barnard's life further, *Immortal Fire* is chock full of footnotes and contains an extensive bibliography. Sheehan's prose is eloquent and easily understandable to ASTRONOMY readers. Barnard's photographs appear throughout, and Sheehan quotes frequently from Barnard's own papers. *The Immortal Fire Within* not only gives the reader a comprehensive overview of Barnard's life, but it also conveys a real feeling for what it was like to be an astronomer at the turn of the century, when the science was undergoing profound transformations. — *Robert Naeye*

Review the first chapter and table of contents of The Immortal Fire Within *on the Internet at: http://dab.psi.net/chapterone/astronomy*

More New Books

Atlas of the Universe

Patrick Moore, (Rand McNally, 1995), ISBN 0-528-83704-4, 272 pages, clothbound, $29.95.

In this completely revised edition, *Atlas of the Universe* presents a cursory look at our current knowledge of astronomy as it's changed since this book was first published in the early 1980s. Astronomy popularizer Patrick Moore offers a lively British style and lavish illustrations to take the reader on a tour of the cosmos. Along the way he explores over everything from spaceflight to the constellations.

Atlas is divided into discrete sections. "Exploring the Universe" covers the human activity of exploring space and the professional tools of astronomy. "Solar System" looks at planets and their moons, asteroids, comets, and interplanetary missions. "The Sun" provides an overview of our star in ten pages. "Stars" details stellar types and their nature, followed by "The Universe," which discusses overall scheme of the cosmos: galaxies (including our own), clusters of galaxies, and the origin and future of the universe.

Rounding out *Atlas* is a star map section that has seasonal charts as well as area charts that encompass at least three constellations and show star names and the position of interesting objects. Finally the book includes tips on how to get started in amateur astronomy.

Astronomical Tables of the Sun, Moon, and Planets

Jean Meeus, (Willmann-Bell, 1995), ISBN 0-943396-45-X, 491 pages, hardcover, $24.95.

Where the 1983 edition only included information to 2005, this second edition of *Astronomical Tables of the Sun, Moon, and Planets* extends astronomical data out to 2020.

What kind of data?

The phases of the Moon down to the second, dates and time of the equinoxes and solstices, and opposition and conjunction dates for not only the planets, but also for many bright asteroids. One table presents the eclipse times of Callisto, the outermost of the Galilean Satellites, by its parent planet Jupiter. In still another table we see date and sky coordinate information for close planetary conjunctions.

Nearly 130 pages of the book contains information on lunar occultations, listing the dates, the object being covered by the Moon, the event's elongation from the Sun (an indication of how easy it is to view) and locations on Earth where the occultation is visible. If you'd like to use a home computer to calculate such information for your location, the author includes a BASIC program.

In other sections, you'll find dates and times of solar and lunar eclipses, records of solar activity, times of lunar apogee and perigee, plus esoteric information such as Moslem and Jewish calendars as well as the dates for Easter through 2119.

If your interest involves moving celestial objects, chances are it's calculated and tabulated here. For that reason, *Astronomical Tables* is not only a valuable observing tool, but an interesting book to browse through as well. ☐

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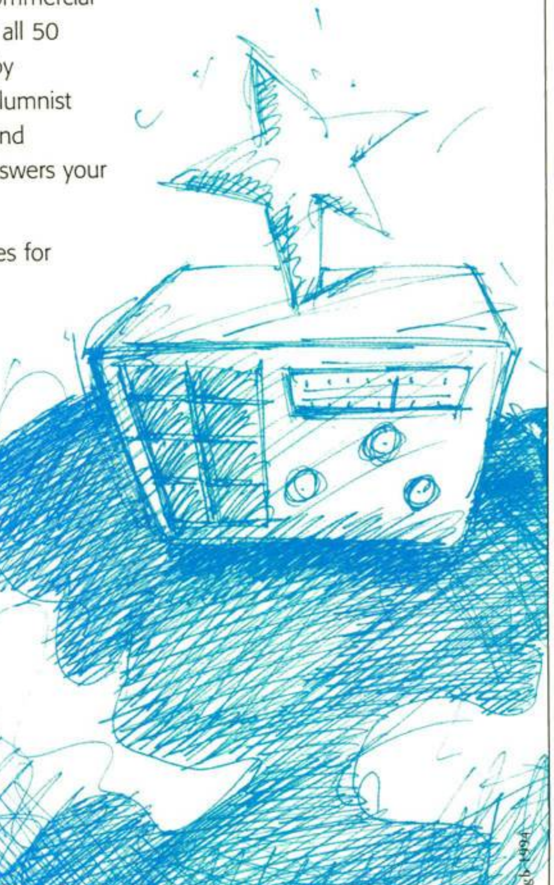

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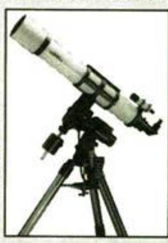

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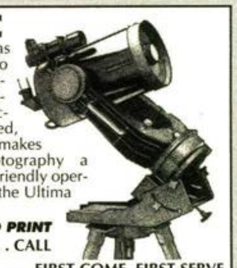

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Upgraded CCD Camera

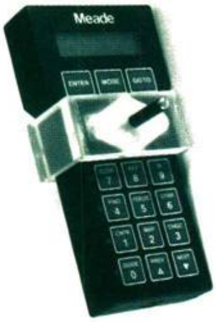
Sirius Instruments has introduced its second-generation CWIP (Camera and Workstation for Image Processing) CCD camera. At the heart of the CWIP-S is a 378 x 240 pixel CCD chip with 12 bits per pixel dynamic range. The camera has built-in image-processing software that makes a computer optional, requiring only the use of a monitor or camcorder. CWIP-S saves dark frames at high resolution for less-noisy pictures. It also stores and retrieves images as digital data from videotape. A redesigned menu offers greater access to camera functions and gives pixel information as the cursor is dragged over an image. When used with a PC, CWIP-S stores files twice as fast as the original CWIP. CWIP-S comes with power adapters, eyepiece adapter, PC software, PC serial cable, and a mouse.

Sirius Instruments, 141 North Charles Avenue, Villa Park, IL 60181. CWIP-S: $999, plus $9 shipping; camera adapter: $29; CWIP camera upgrade package: $99.

CCD Focusing Eyepiece

The IFocus eyepiece allows SBIG CCD camera owners to focus and center objects in the field before hooking up the camera. The eyepiece's focal length is identical to the distance between the back of the telescope and the camera's CCD chip. Because it is parfocal with the camera, IFocus works in conjunction with reducers, Barlow lenses, and filters. When ordering, specify your SBIG camera model.

Software Bisque, 912 12th St., Suite A, Golden, CO 80401, (303) 278-4478, (800) 843-7599, fax (303) 278-0045. $129.



LX200 Joystick

Canadian observer Robert Roy got tired of pushing button controls on his LX200's control pad, so he invented this joystick accessory. Two small set screws hold Roy's joystick housing over a portion of the LX200's hand paddle, where it rests on the directional buttons. When pushed a certain direction, the joystick depresses these directional buttons to slew the telescope. The joystick operates all models of Meade LX200 Schmidt-Cassegrain telescopes.

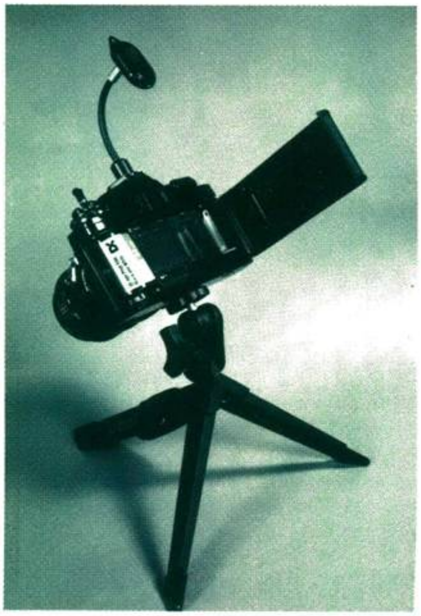
Robert G. Roy, RR #2, Binbrook, Ontario L0R 1C0, Canada, (905) 692-3245. $39 (US).

1¼-inch Zoom Eyepiece

Celestron's deluxe 1¼-inch zoom eyepiece comes multicoated and has a focal-length range of 18 mm to 6.5 mm. Its hybrid optical design boasts superb image definition. The eyepiece's total weight is five ounces.

Celestron International, 2835 Columbia Street, Torrance, CA 90503, (310) 328-9560, fax (310) 212-5835. Deluxe Zoom Model #93306: $234.

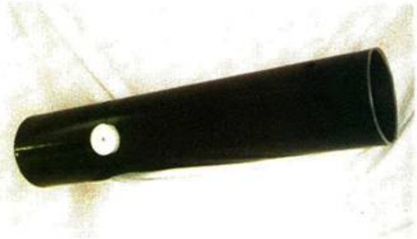
This department presents new product announcements issued by manufacturers. Product information is as supplied by the manufacturers or distributors. All prices are suggested retail. Suppliers should send announcements and color photographs of their products to the attention of John Shibley.



Slide-on Camera Light

Camlite slides into any camera's hot shoe flash mount to illuminate camera controls in darkness. The two-ounce light also attaches to flat edges with a clip mount. Camlite's wide-angle red LED is powered by a lithium battery.

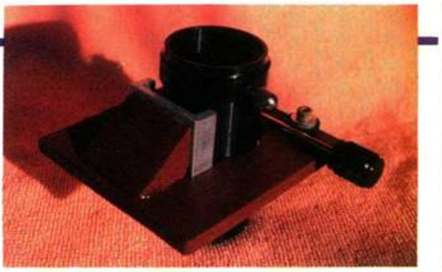
BPS Marketing, 19807 NE 160th Place, Woodenville, WA 98072, (206) 788-4007, fax (206) 788-4007. $16.95.



Newtonian Tube Assemblies

Telescope makers can now order ready made Newtonian tube assemblies for 6-, 8-, and 10-inch mirrors. Each tube is made from rolled fiberboard that has a glossy, durable, black finish. Assemblies come with holes that accept 1¼-inch focusers and have removable Dobsonian rollers. A built-in mirror cell with spring-loaded flotation allows for easy optical collimation. North Star Systems also custom-builds assemblies for a variety of mirror sizes and focal lengths. Every order comes with construction plans for a Dobsonian mount.

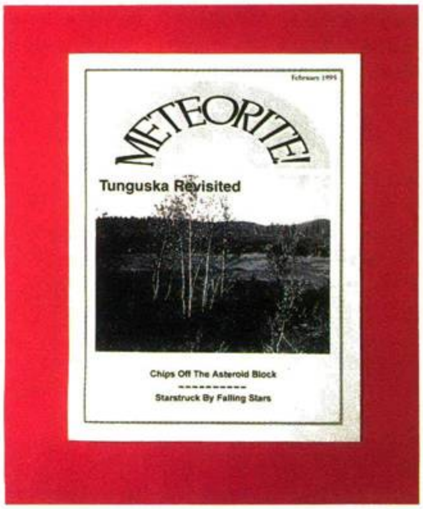
North Star Systems, P.O. Box 99, Ellenburg Depot, NY 12935, (518) 594-7250. Tube assembly for 6-inch f/8 mirrors: $40; 8-inch f/6: $50; 10-inch f/4.5: $60; 10-inch f/5.6: $65. Custom orders add $25. Shipping: $15.



Low-cost Focuser

For do-it-yourself telescope builders, telescope maker Mike Fallwell sells a Crayford-style focuser that fits telescope tubes with outside diameters between four and 18 inches. The focuser accepts 1¼-inch eyepieces and racks in and out one inch. An aluminum eyepiece tube rides on four ball-bearings and two teflon pads. One turn of the focuser's knob translates into ⅜" of tube travel. Each focuser weighs four ounces and accommodates loads up to 24 ounces. Fallwell sells the focusers assembled and in kits.

Mike Fallwell, 26871 Alessandro Blvd., Unit 50, Moreno, CA 92555-3916. (909) 486-9116. Assembled focuser: $45; kit: $29. Shipping and handling: $5. California residents add 7.5 percent. Send SASE for more information.



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Pallasite Press, P.O. Box 33-1218, Takapuna, Auckland, New Zealand, fax 011-64-9-489-6750. One year subscription: $18 (US).

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MEETINGS & EVENTS

June 1-August 30
Summer Observing Sessions, Naperville, Illinois. The Naperville Astronomical Association will operate a 10" telescope at 7:30 p.m. Contact George Simon, (708) 983-5029.

July 21-22
Summer Seminar, near Syracuse, New York. Contact Robert Ostrander, Syracuse Astronomical Society, 1301 Valley Drive, Syracuse, NY, 13207, (315) 469-9285.

July 22-30
Summer Star Party, Savoy, Massachusetts. Contact Don Urban, 73 Haring St., Rockland Astronomy Club, Closter, NJ 07624-1709, (201) 768-6575.

July 25-30
Nebraska Star Party, near Valentine, Nebraska. Contact Nebraska Star Party Coordinator, (402) 466-4170.

July 27-30
Huronia Star Party, Lisle, Ontario. Contact Henri Van Bemmel, 140 Erskine Ave., # 1502, Toronto, Ontario, M4P 1Z2 Canada, (416) 481-9937.

July 28-29
The Ohio Turnpike Astronomers Assoc. Convention, Oberlin, Ohio. Contact Bill Gerling, The Cuyahoga Astronomical Association, (216) 779-9779.

July 28-30
Rocky Mountain Star Stare '95, Pike National Forest, Colorado. Contact Mike Frazier, P.O. Box 62022, Colorado Springs, CO 80962, (719) 591-9349.

July 28-30
Star Party, Austin, Minnesota. Contact Keith Snyder, Cedar River Astronomy Club, 407 15th St. S.E., Austin, MN 55912, (507) 433-1903.

August 4-6
Millennial Foundation Conclave, Denver, Colorado. Contact Theresa Hamilton, P.O. Box 347, Rifle, CO 81650, (303) 625-5052.

August 5-6
Curious Color Cosmos, Blackcomb Mountain, British Columbia. Contact John Nemy, The Pacific Observatory, P.O. Box 1218, Whistler, B.C., V0N 1B0 Canada, (604) 932-3467.

August 12
Perseid Meteor Shower, Blackcomb Mountain, British Columbia. Contact John Nemy, The Pacific Observatory, P.O. Box 1218, Whistler, B.C., V0N 1B0 Canada, (604) 932-3467.

August 24-27
Oregon Star Party, Ochoco Mountains, central Oregon. Contact Chuck Dethloff, P.O. Box 91416, Portland, OR 97291-0416, (503) 357-6163, dethloff@uofport.edu.

August 25-27
Montana Starwatch, Virginia City, Montana. Contact Mike Murray, Museum of the Rockies, MSU, Bozeman, MT 59717, (406) 994-6891, ammmm@gemini.oscs.montana.edu.

August 25-27
Annual Northwoods Starfest, Hobbs Observatory, Fall Creek, Wisconsin. Contact Ray Forsgren, 4856 Inlet Drive, Chippewa Falls, WI 54729.

August 25-27
Eastern Iowa Star Party, near Dixon, Iowa. Contact William Myers, Quad Cities Astronomical Society, P.O. Box 3706, Davenport, IA 52808, (319) 359-4286.

August 25-27
Starfest 95, Mount Forest, Ontario. Contact Andreas Gada, North York Astronomical Association, 26 Chryessa Ave., Toronto, Ontario, M6N 4T5 Canada.

August 25-27
The Conjunction, Northfield, Massachusetts. Contact Jack Megas, 311 Surrey Road, Springfield, MA 01118.

August 25-27
Weekend Under the Stars, Foxpark, Wyoming. Contact Martin Curran, Cheyenne Astronomical Society, 3539 Luther Place, Cheyenne, WY 82001, (307) 635-5944.

August 25-27
Southern Idaho Regional Star Party, Bruneau Dunes State Park, Idaho. Contact Sam Johnson, P.O. Box 8386, Boise, ID 83707, (208) 939-2095.

September 2
Island Lake Star Party, Brighton, Michigan. Contact The Ford Amateur Astronomy Club, P.O Box 7527, Dearborn, MI 48121-7527, (313) 390-5456.

September 15-17
Astrofest, near Kankakee, Illinois. Contact Astrofest Registrar, the Chicago Astronomical Society, P.O. Box 596, Tinley Park, IL 60477-0596, (312) 725-5618.

September 20-23
Twin Lakes Star Party, Golden Pond, Kentucky. Contact Jim Boren, West Kentucky Amateur Astronomers, 262 Shane Lee Circle, Dover, TN 37058, (615) 232-6820.

September 21-24
Great Plains Starfest, Kansas Flint Hills, Kansas. Contact Bob Nederman, Astrophotographer's & Observer's Society, 9200 Westerbrooke Drive, Overland Park, KS 66214.

September 22-23
Dark Sky Observing Party, Panaca, Nevada. Contact Jim Mellor, Las Vegas Astronomical Society, 7470 Schirlls Street, Las Vegas, NV 89139, (702) 361-1356, or Val Picotte, 7631 N. Jones Boulevard, Las Vegas, NV 89131, (702) 656-0961.

September 22-23
East Coast Star Party, Coinjock, North Carolina. Contact Kent Blackwell, 1169 Old Kempsville Road, Virginia Beach, VA 23464.

September 22-24
Connecticut Star Party, Colebrook, Connecticut. Contact Joel Marks, Astronomical Society of New Haven, P.O. Box 5032, Milford, CT, (203) 874-4816.

September 22-24
Nightfall, Borrego Springs, California. Sponsored by the Riverside Telescope Makers Conference. Contact Nightfall, Fox & Stephens, 9045 Haven Ave., Suite 109, Rancho Cucamonga, CA 91730, or leave message at (909) 948-2205.

September 27-29
Symposium of the Astronomical Society of Southern Africa, Bloemfontein, South Africa. Contact the Education Centre, ASSA Symposium, Bloemfontein, 9301 South Africa, 051-365-395 or fax 051-365-397. □

Clubs, please submit announcements four months before the event to ASTRONOMY*, Meetings & Events, P.O. Box 1612, Waukesha, WI 53187-1612. Readers, please include a self-addressed envelope when you write groups for information.*

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Dog Days (page 40)

Light and Color in the Outdoors by M.G.J. Minnaert, (Springer-Verlag, 1993). A classic book on atmospheric phenomena with a discussion of twinkling stars.

Bloopers (page 66)

"Beating Back the Guiding Gremlins," by Alan Dyer, ASTRONOMY, September 1994. A detailed look at how to produce well-guided deep-sky photos.

"Seeking the Best 35mm Camera," by Alan Dyer, ASTRONOMY, September 1993. A review of the best new and used manual cameras.

"Getting Focused on Sharper Photos," by Chris Schur, ASTRONOMY, July 1993. Lots of information on accurately focusing a camera on a telescope.

"Life in the Fast Lane," by Alan Dyer, ASTRONOMY, May 1995. A review of the fastest slide films for available for astrophotography on the market.

"Getting the Exposure Right," by Alan Dyer, ASTRONOMY, September 1992. Recommended exposures for all types of celestial subjects.

Bino Mount (page 71)

"Build a Universal Tripod," by M. Leon Knott, ASTRONOMY, August 1992. Instructions and parts list for building a sturdy tripod of any height for use with scopes and binoculars.

Star Hopping (page 74)

"Hop Into Deep-Sky Observing," by Marcel W. Bergman, ASTRONOMY, September 1992. Winning techniques for star hopping among deep-sky objects.

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p. 57: Larry E. Steenhoek; **p. 62:** Jean-Guy Moreau; **p. 67, M31:** 4-inch apochromatic refractor, f/4.5, 35 minutes, Ektachrome 1600 film at ISO 800; **p. 68, North America Nebula:** 4-inch apochromatic refractor, f/4.5, 40 minutes, ScotchChrome 400 film at ISO 800; **p. 105, top:** Cary Smialek, 50mm lens at f/2, Ektachrome 400 film, taken January 3, 1995, from near Edmonton, Alberta; **bottom left:** James R. Foster, 14-inch SCT at f/7, hypersensitized Fuji Super HG 400 film; **bottom right:** Chris Cook, 8-inch SCT at f/6, hypersensitized Tech Pan film, 75-minute exposure; **p. 106, top:** Antonio Vidal, 16-inch f/4 reflector, ST-6 CCD camera, 3-minute exposure on September 11, 1994; **bottom:** John Marrari, 50mm lens at f/2.8, ScotchChrome 400 film pushed to ISO 800, 2-second exposure on January 27, 1995, from Pewaukee, Wisconsin; **pp. 106-107**: Michael Stecker, 8-inch f/4 astrograph, Fujicolor 400 film, composite of two 45-minute exposures; **p. 107, bottom left:** James R. Foster, 14-inch SCT at f/11.5, hypersensitized Fuji Super HG 400 film, 210-minute exposure; **bottom right:** M. L. Clark, 5-inch f/5 refractor, Fuji Super HG 400 film, 15-minute exposure on August 28, 1994; **p. 108, top:** Bill and Sally Fletcher, 16-inch reflector at f/4.5, tricolor composite made with Tech Pan film and exposures of 1/125-second (red and green) and 1/60-second (blue) on February 15, 1995; **middle:** Bill and Sally Fletcher, 8-inch f/4.5 reflector, tricolor composite made with Tech Pan film and exposures of 65 minutes (red), 90 minutes (green), and 125 minutes (blue); **bottom:** George Greaney and Dean Easton, 6-inch f/7 refractor, Fuji Super HG 400 film, composite of two 60-minute exposures; **p. 109:** Luke Dodd, 55mm lens, Fuji 400 film, composite of two 25-minute exposures; **p. 110:** John Flinn, 20mm lens at f/2.8, Ektachrome 400 film, taken October 31, 1991, from Alaska. ☐

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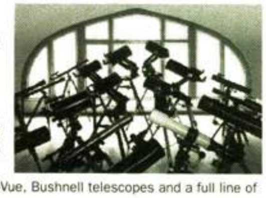

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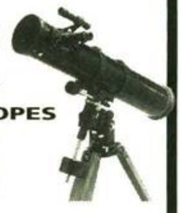

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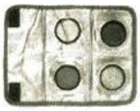

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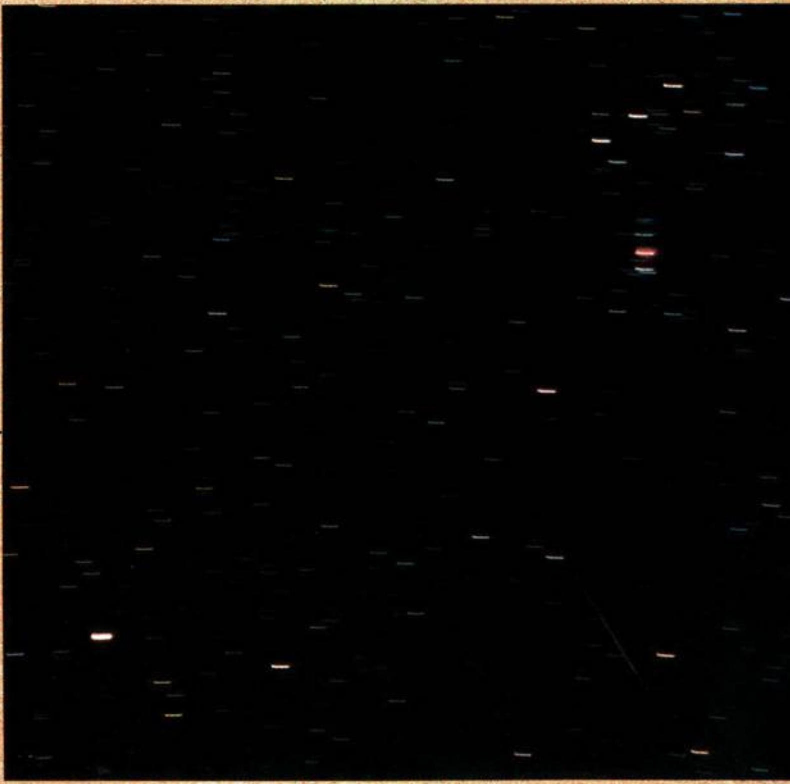
READER REPORTS

A Magical Meteor Moment

Cary Smialek wanted to see and photograph a Quadrantid. He was going out to observe one, in fact, for the first time. The Quadrantid meteor shower delivers some 85 meteors streaking overhead each hour at its peak activity during the early morning of January 4. For Smialek, a magical moment lay ahead.

He packed his meteor observing gear and drove to the Blackfoot Integrated Use Area, a parklike setting often used by members of the Royal Astronomical Society Centre in Edmonton, Alberta. It was a cold winter's evening, January 3, 1995, and the mercury hovered at a chilly 12° F. This did not deter Smialek from his mission, nor did it halt the half-dozen friends who met him at the site. "As I stepped out of the car my first impressions were of snow, cold, and the beauty of the sky," says Smialek. "The sky was moonless and clear, the air filled with the anticipation that accompanies a meteor shower."

Unfortunately, Smialek's arrival coincided with a sharp dropoff in Quadrantid activity. The shower displays a sharp peak in activity that was predicted to occur at 4 p.m. MST, and it was now 7:30 p.m. A fellow club member, Russ Sampson, had been counting Quads. After 53 minutes he recorded 10. "It indeed appeared that we had passed the peak of activity," says Smialek. "We were occasionally rewarded by seeing a bright Quad, several of which arched across 40° of sky." Smialek had seen his Quadrantid.



A Quadrantid Falls Below Orion

by Cary Smialek
(50mm lens at f/2, Ektachrome 400 film, taken January 3, 1995, from near Edmonton, Alberta)

The Tarantula Nebula

by James R. Foster
(14-inch SCT at f/7, hypersensitized Fuji Super HG 400 film)

The Helix Nebula

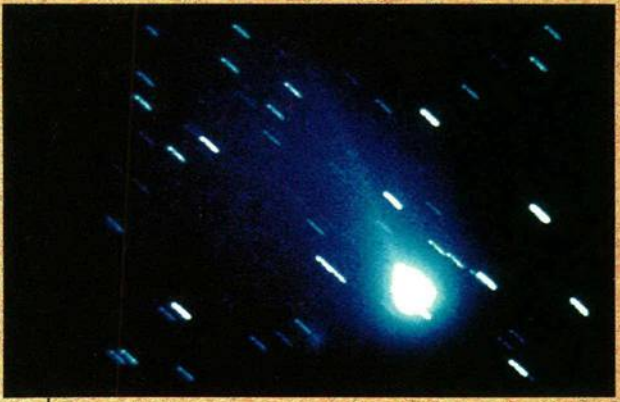
by Chris Cook
(8-inch SCT at f/6, hypersensitized Tech Pan film, 75-minute exposure)

At about 10 p.m., most of the party decided to pack it in, leaving Smialek and fellow observer Barry Arnold. After viewing some deep-sky objects with Arnold's 16-inch scope, Arnold and telescope left, leaving Smialek all alone with the drizzling remnants of the meteor shower overhead. He decided to try recording a Quadrantid on film, and set up his camera with moderate speed slide film and a cable release.

The frigid temperature caused the camera's mirror to remain locked in its up position, such that Smialek couldn't see exactly what was in his field of view. He simply had to aim it roughly toward an area of sky and begin an exposure. By now the frigid cold was getting to Smialek and his cable release had the action of a syringe filled with peanut butter. Auroral activity was brightening the northern horizon with a pretty, greenish glow.

"I watched the aurora brighten from the car, where I was reintroducing warmth into my body," says Smialek. "I had set up the camera to take a time exposure of another pleasing scene, which included a treeline, the belt stars of Orion, and Sirius. As I focused on the beauty of this scene a bright Quadrantid ripped across Lepus, right below Orion, and straight through my camera's field." All was well despite the uncomfortable cold. Smialek had photographed a Quadrantid. "The night returned to a dark stillness," he says. "And I returned with great memories of my Quads."

ASTRONOMY wants to hear about your observations of the sky. Send reports, sketches, and photographs to David J. Eicher, Reader Reports Editor, ASTRONOMY, P.O. Box 1612, Waukesha, WI 53187. Please label each photo with name, address, and social security number. You may send written reports via the Internet to: rreports@astronomy.com



Comet Machholz 2

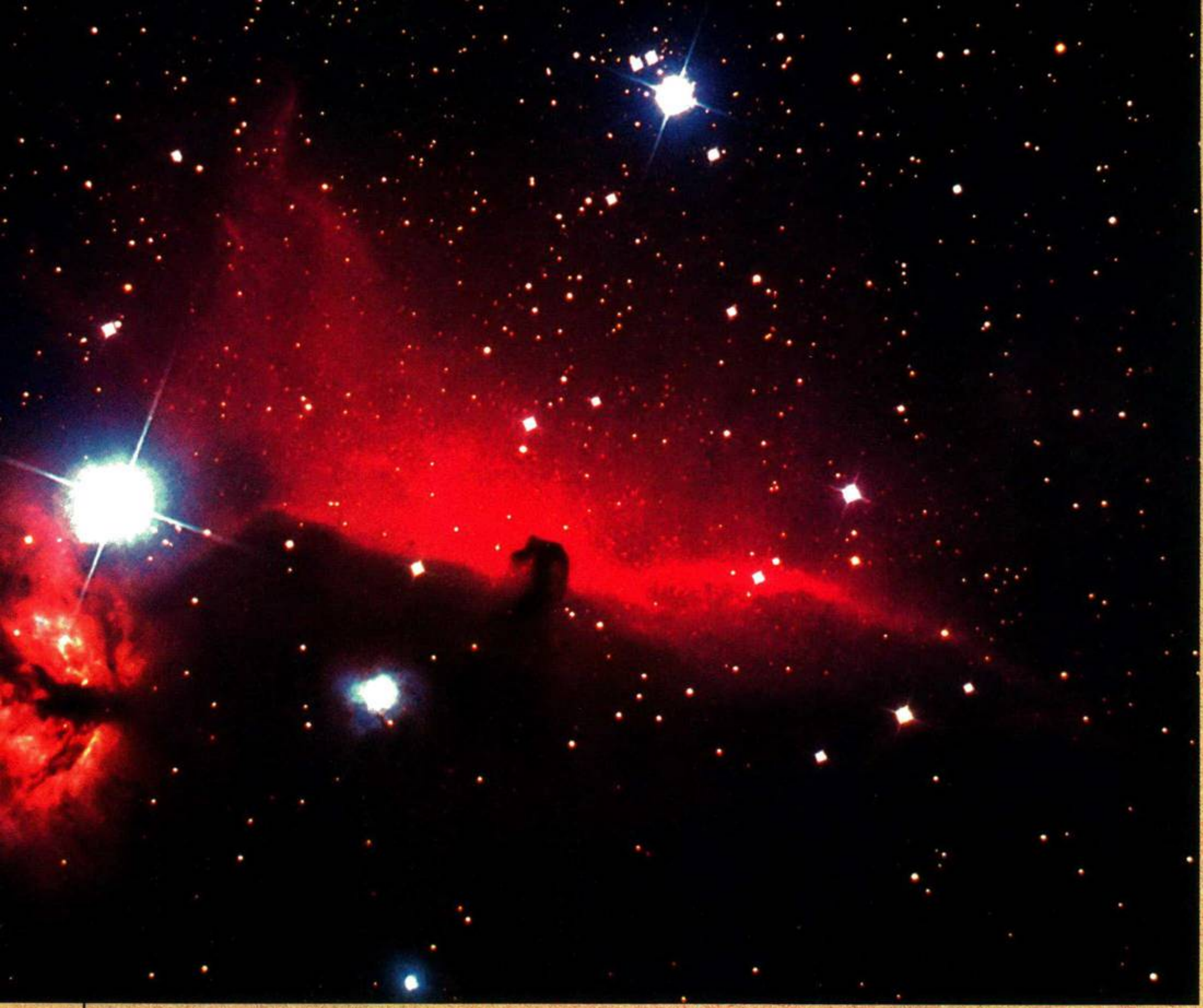
by Antonio Vidal
(16-inch f/4 reflector, ST-6 CCD camera, 3-minute exposure on September 11, 1994)

The Moon Meets Venus and Jupiter

by John Marrari
(50mm lens at f/2.8, Scotchchrome 400 film pushed to ISO 800, 2-second exposure on January 27, 1995, from Pewaukee, Wisconsin)

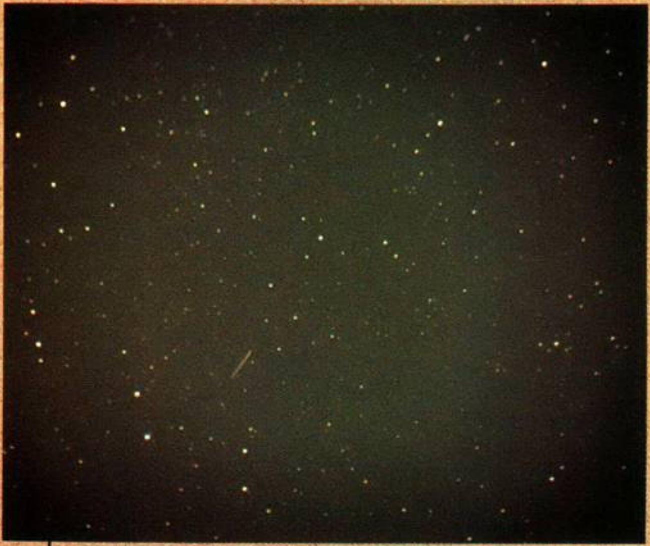
The NGC 3190 Galaxy Group

by James R. Foster
(14-inch SCT at f/11.5, hypersensitized Fuji Super HG 400 film, 210-minute exposure)



The Horsehead Nebula

by Michael Stecker
(8-inch f/4 astrograph, Fujicolor 400 film, composite of two 45-minute exposures)



Asteroid 1620 Geographos

by M.L. Clark

(5-inch f/5 refractor, Fuji Super HG 400 film, 15-minute exposure on August 28, 1994)

The Moon in Tricolor

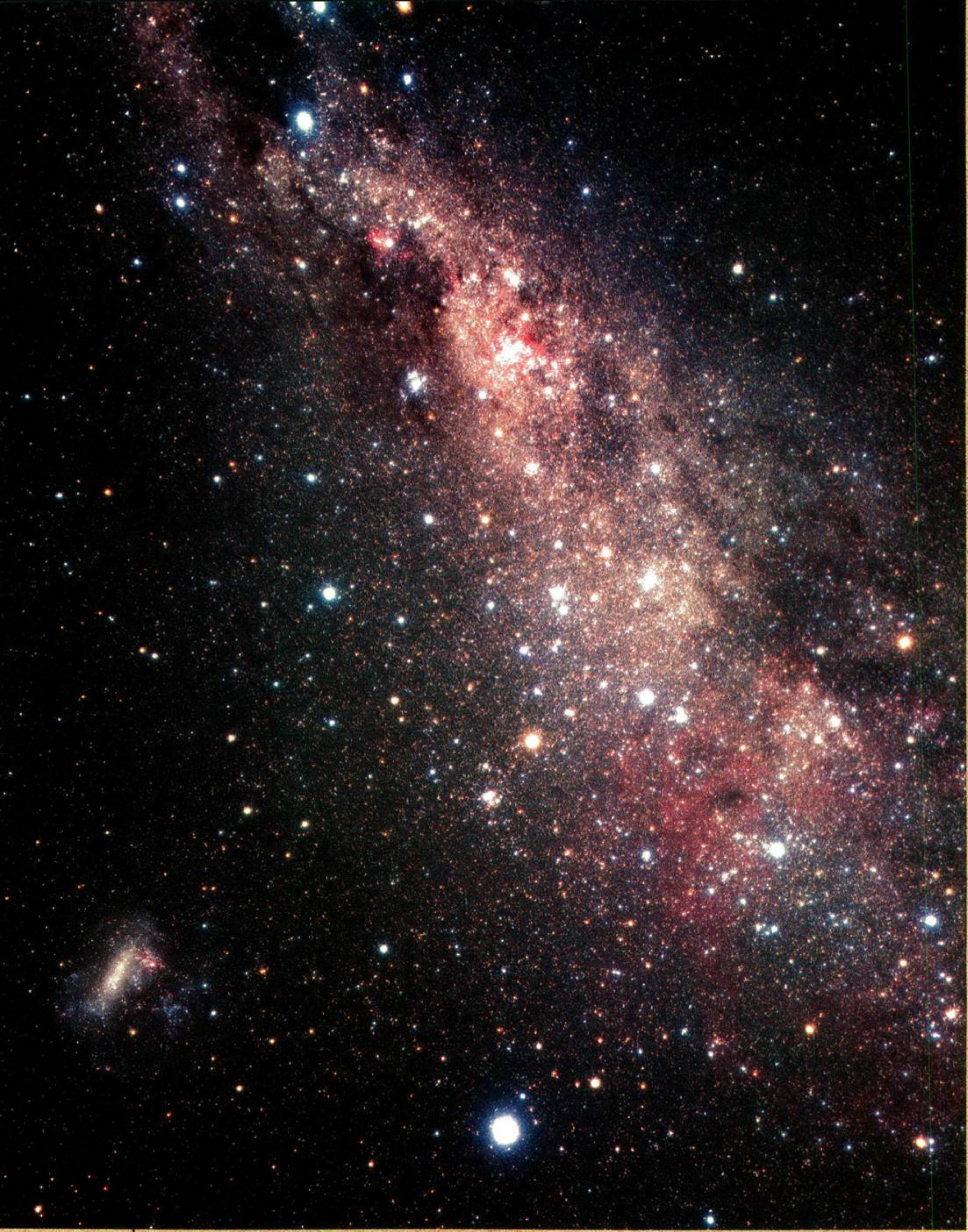
by Bill and Sally Fletcher
(16-inch reflector at f/4.5, tricolor composite made with Tech Pan film and exposures of 1⁄125-second [red and green] and 1⁄60-second [blue] on February 15, 1995)

The Rosette Nebula

by Bill and Sally Fletcher
(8-inch f/4.5 reflector, tricolor composite made with Tech Pan film and exposures of 65 minutes [red], 90 minutes [green], and 125-minutes [blue])

Sharpless 2-129 and van den Bergh 140

by George Greaney and Dean Easton
(6-inch f/7 refractor, Fuji Super HG 400 film, composite of two 60-minute exposures)



Carina, Vela, and Puppis

by Luke Dodd
(55mm lens, Fuji 400 film, composite of
two 25-minute exposures)

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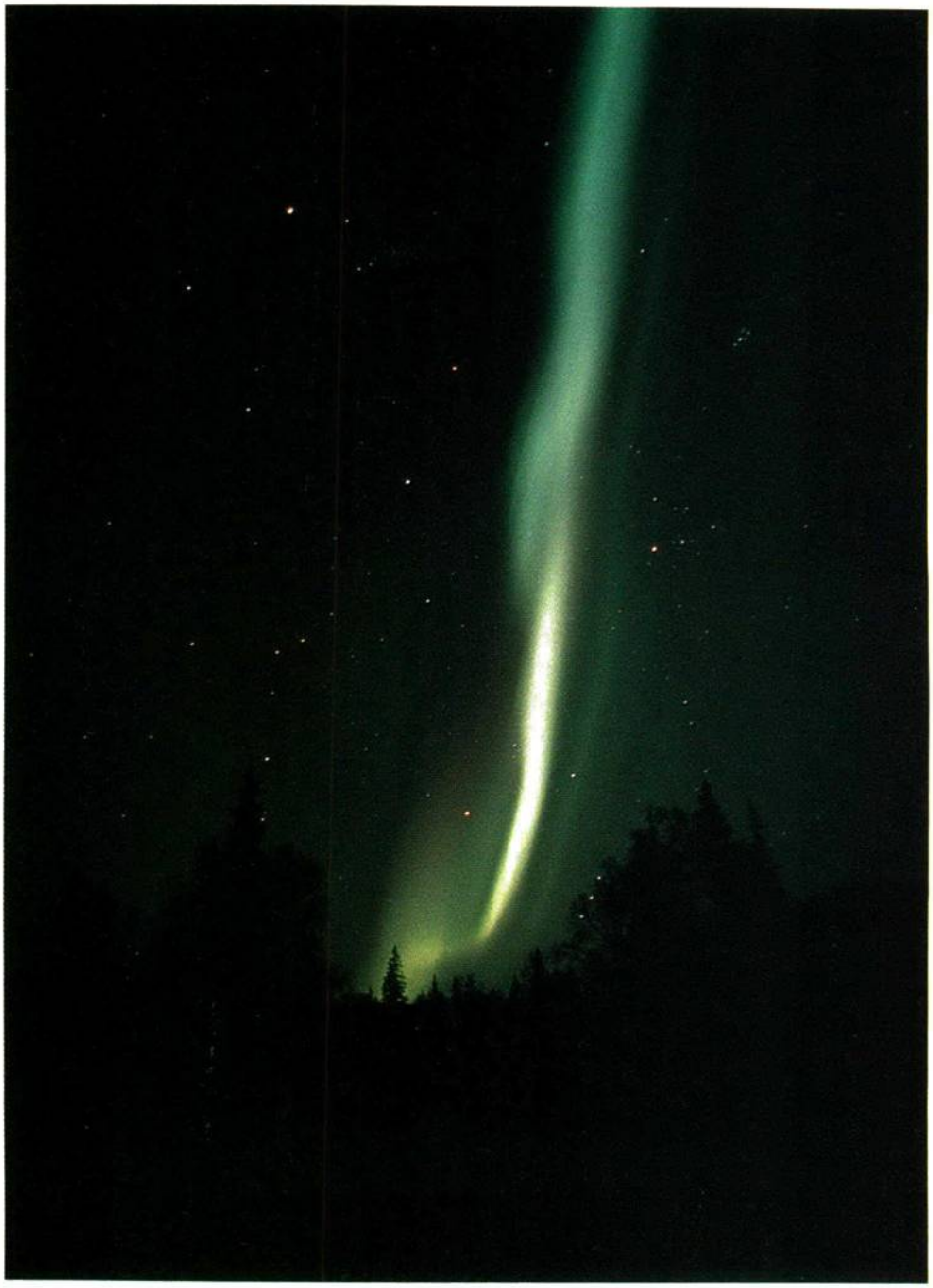


An Aurora Separates Auriga and Taurus

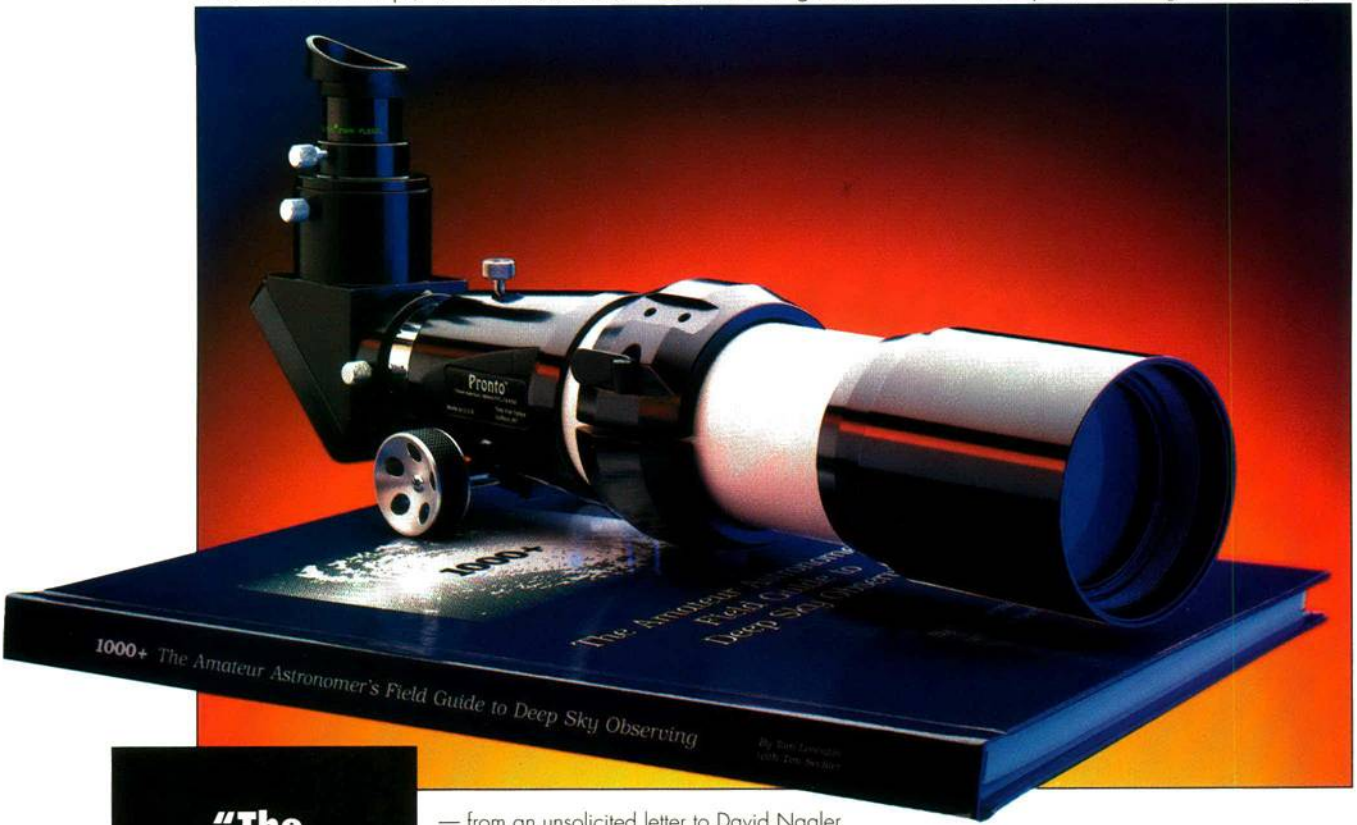
by John Flinn
(20mm lens at f/2.8, Ektachrome 400 film, taken October 31, 1991, from Alaska)

"This spectacular auroral show was not only bright but it moved slowly," says Flinn. "That enabled me to capture it on film in different stages as it unfolded over about an hour.

"I was particularly struck by the vivid colors of this aurora and how they danced quickly around the bright constellations Auriga, Taurus, Orion, and Perseus. I was fortunate to be situated near Denali National Park in Alaska where the sky was quite dark."

PRONTO

Pronto: 70mm Ap., 480mm F.L., f/6.8 E.D. doublet, 2" diagonal, 21mm Plössl, adapter, mount ring, shoulder bag std.


Pronto
1000+ The Amateur Astronomer's Field Guide to Deep Sky Observing

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— from an unsolicited letter to David Nagler

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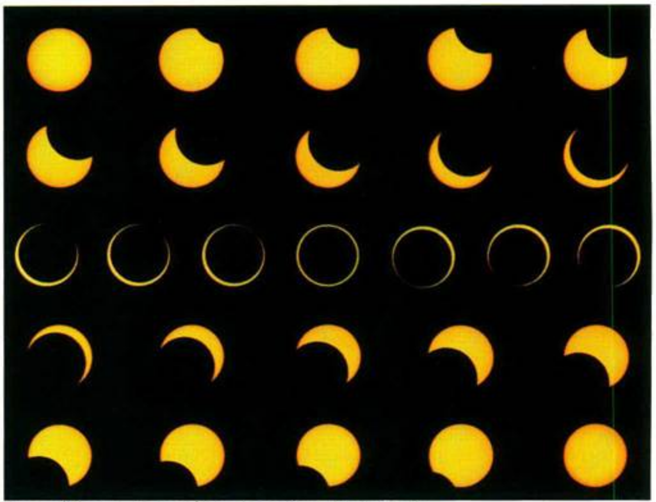
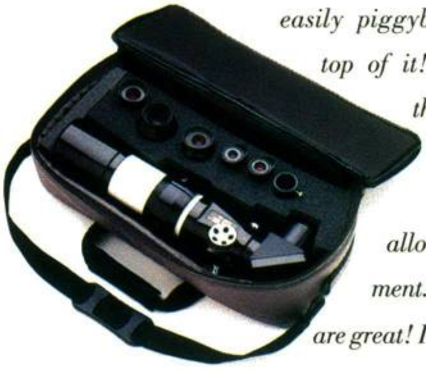
Back in May '94, North America was witness to a spectacular annular solar eclipse! Having planned the event for almost a year, a lot of equipment was brought with me for the big day. The last thing I needed was a scope that took up a lot of room or would be difficult to use or set up. The Pronto's compact size and light weight made it possible to easily piggyback a camcorder on top of it! Taking photographs through the Pronto is a snap. The smooth 2" rack & pinion focuser allows precise focus adjustment. The optics of the Pronto are great! It performed wonderfully! Thank you for the fine products offered by Tele Vue.

Best regards and clear skies, — Dan Folz, IL



Array of Pronto photos of annular eclipse, by Dan Folz



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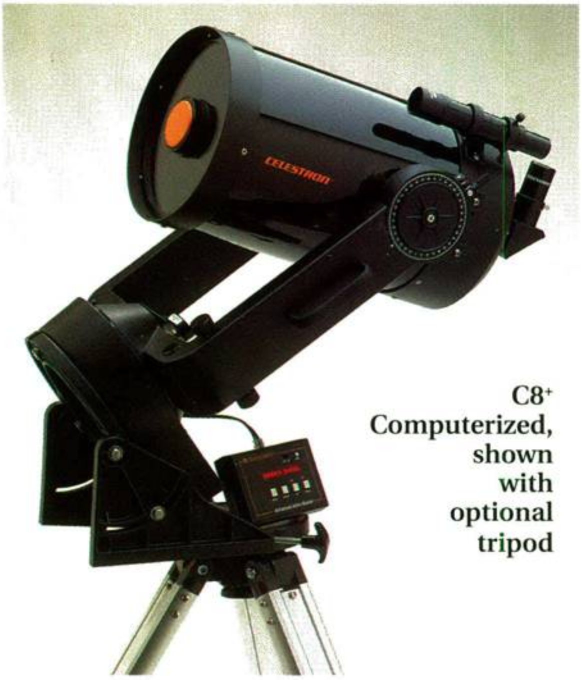

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